Aircraft ARMAMENT

✓ U.S. Bureau of naval personnel

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NAVY TRAINING COURSES

AIRCRAFT ARMAMENT

PREPARED BY

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PREFACE

This book is written for the enlisted men of Naval Aviation. It is one of a series of books designed to give them the background information necessary to perform their aviation duties.

A knowledge of aircraft armament is of primary importance to Aviation Ordnancemen responsible for general maintenance work. But the subdivisions of Aviation Ordnancemen—that is Aviation Bombsight Mechanics and Aviation Turret Mechanics—also need an understanding of aircraft armament. They need to know the relationship of their specialties to the broad subject of ordnance.

Starting with a general discussion of what to do with armament, this book follows with a discussion of how guns operate, and types of guns—Browning Machine gun and 20 mm automatics. Then come racks and shackles and bomb release systems. In conclusion, there is a section on bomb-handling equipment.

As one of the NAVY TRAINING COURSES, this book represents the joint endeavor of the Naval Air Technical Training Command and the Training Courses Section of the Bureau of Naval Personnel.

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AIRCRAFT ARMAMENT

CHAPTER 1

KNOWLEDGE PAYS DIVIDENDS

WHAT TO DO

A carrier task force is steaming along under the cloudless Pacific sky. On the flight deck of the carrier, the air is tense with expectation. Airplanes of the fighter squadrons are in contact with the enemy. A major engagement is developing.

As the flight deck crews eagerly scan the sky to the west, a few specks appear—then more—and still more. The carrier's planes are returning to the ship to be refueled and rearmed, so that they can be off again to the fight.

You and your mates, waiting on that carrier flight deck, are responsible for getting those airplanes back into the air again—BUT FAST. You're a member of a re-arming crew—a big cog in a team that's playing the game for keeps. Your responsibility this time is the bombs, or the rockets, or the guns.

Whatever it is, it's time to GET BUSY. The returning planes swoop down onto the deck and roll to a quick stop. The re-arming crews swarm over them as the pilots and crewmen climb out.

You're working against time now. Every minute counts. You find some trouble you didn't figure on—a gun has jammed. O. K. Extra work, but no extra time.

How do you measure up? DO YOU KNOW YOUR

STUFF? CAN YOU GET THAT AIRPLANE BACK IN FIGHTING TRIM IN RECORD TIME?

You, as an Aviation Ordnanceman, have a major role in maintaining the driving offensive power of Naval Aviation. Fighting airplanes are designed and built for one purpose—to fight. The weapons they fight WITH are YOUR RESPONSIBILITY.

A big responsibility? You bet it is. It's the pay-off that counts.

A bomber is going to bomb an enemy base. Mechanics have spent precious time checking over the engines, ordnancemen have loaded the bombs, and intelligence officers have spent long hours collecting the necessary information for the pilots and the crew. Everything is set.

After a long flight in heavy weather, the bomber reaches its objective. Fighting in through heavy anti-aircraft fire, the bomber lets go with a 2,000 pound bomb. The missile screams earthward, and lands squarely on the target. Scratch one target!

Why was the mission a success? Partly because you KNEW YOUR EQUIPMENT, and KNEW HOW TO APPLY YOUR KNOWLEDGE.

Before long you'll feel as much at home with a high explosive bomb, as you do with an old pair of shoes. And it's when you get that old "I-REALLY-KNOW-MY-STUFF" feeling that you've got to watch your step.

Here's an example—

You're loading up the squadron airplanes with bombs. You're hauling a truckload of them over the concrete runway. Sure, you lashed them on the truck just as you've done a hundred or more times before—BUT—this time you didn't double check to see that your lashings were secure. As you head out toward the waiting planes, one of your bombs slips off the truck and drags along the concrete. The friction heats up the explosive inside until—WHAM!

You'll never know what happened, but your carelessness did more damage and caused more casualties than a major enemy raid—not to mention what it did to you personally.

Take another example—

A gun is completely impersonal. It will drill just as big a hole through you—or your best pal—as it will through one of the enemy. Many a good man has been tagged with that famous last line—"He didn't know it was loaded!"

KNOWLEDGE and CAUTION are the keynotes to a successful and a healthy career in Aviation Ordnance. "Knowing your stuff" not only means knowing WHAT TO DO, but also WHAT NOT TO DO. In every aspect of your training and your work, "SAFETY FIRST—DON'T TAKE CHANCES," is a fundamental law and slogan.

YOUR DUTIES

As an Aviation Ordnanceman, what will you have to do?

You'll be an expert on all of the guns used by your outfit. They'll range from a cal. .22 training pistol up to a 20 mm aircraft cannon. You'll have to keep them in tip-top condition—disassemble them, make repairs, put them back together again, install them in the airplanes.

You'll have to take care of all of the bomb releasing gear—the racks, shackles, and other equipment by which bombs are dropped from airplanes.

You'll be handling all of the munitions—the ammunition for the guns, the bombs, torpedoes, rockets, mines, pyrotechnics, and their component parts—and loading them into the airplanes.

You'll be working with gunsights, bombsights, torpedo directors. You'll have to correlate sights and guns, and you will install and adjust delicate synchronizers—the mechanisms that fire guns so the bullets pass between the propeller blades.

This book will help you to grasp the fundamentals of your duties. But don't neglect other printed matter. Aviation ordnance is changing rapidly. Improvements in equipment are being made constantly and new and better weapons are being developed. You can keep abreast of all of these changes through the publications issued by the Bureau of Ordnance. There are the OP–s, or Ordnance Pamphlets, which will give you a detailed account of the construction and operation of the various pieces of equipment.

Also, there are OTI–s, or Ordnance Technical Instructions. These are timely bulletins, (in many cases they will supplement the OP–s) which will give you information on possible malfunctions in certain equipment and how to meet them, and which will recommend certain changes in operating procedure.

There are other BuOrd publications that you will want to read and study. Find out who is in charge of them on your ship or station. Keeping abreast of BuOrd publications will not only make you a more valuable man—it will make your work easier for you.

EQUIPMENT DESIGNATIONS

So that you can readily identify different designs, every piece of aviation ordnance equipment has a definite MODEL DESIGNATION, consisting of a combination of letters and numbers. Most important and most common are the designations by MARK and by MODIFICATION — abbreviated Mk., and MOD.

MARK is the term used to identify a new design or pattern of any one type of equipment. Take, as an example, a bombsight. The first design of a bombsight would be the Mark 1, or Mk. 1. If the bombsight is completely redesigned, the new model would be the Mk. 2.

A MODIFICATION, however, denotes a slight change in an original design, not affecting the basic design itself. Take the hypothetical Mark 1 bombsight again. If certain improvements in the sight were made, though the sight remained essentially the same, the designation would be Bombsight Mk. 1, Mod. 1. "Mod." for "modification."

Many pieces of aviation ordnance equipment are assigned SERIAL NUMBERS. Each single piece of the equipment will have its own serial number, and a record of each individual unit is kept by means of this number.

Many ordnance items are purchased from the War Department by the Navy, and you will find that these will carry the Army's designations. They are similar to those used by the Navy, except that in place of "Mk," the Army uses "M"—thus, M–1, M–2, is the designation of different designs.

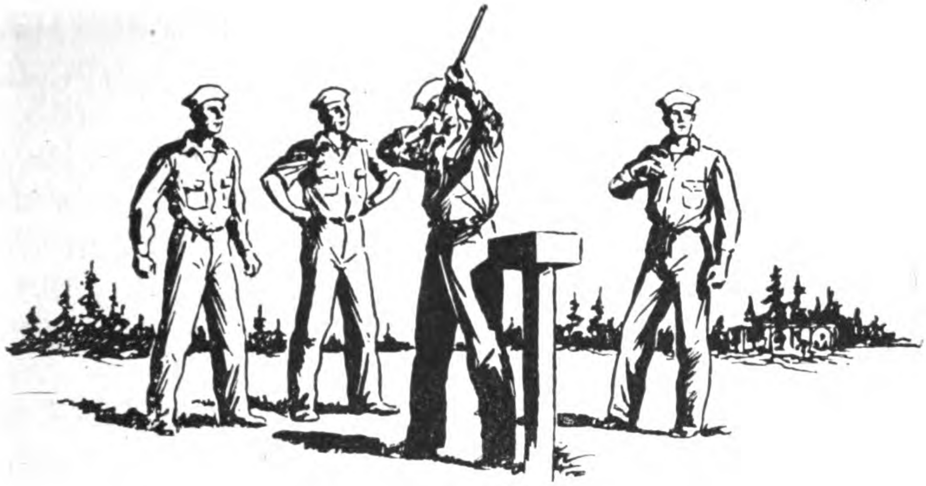
An item carrying the designation "AN" has been standardized for use in both Army and Navy aircraft. This designation will always PRECEDE the Mark designation, as "AN–Mk.6."

These are the principal designation symbols that you will be dealing with, and when you are submitting any written reports on any equipment, you must always refer to each new item mentioned in your reports by its COMPLETE designation, so that there will be no possibility of a misunderstanding.

A WORD OF WARNING

Be careful where you TALK about your weapons and your work. Almost all information about ordnance is CLASSIFIED MATTER—restricted, confidential, or even secret. The enemy would give a lot for only a small part of your knowledge.

So if you MUST talk ordnance "out of shop," see to it that you limit your discussion to topics of historical interest — such as bows and arrows, sling-shots, or flint-lock muzzle loaders.



CHAPTER 2

HOW GUNS OPERATE

THE A B C OF GUNS

Consider the PEASHOOTER.

It doesn't look like much of a weapon—except when South American tribesmen use it to shoot poison darts. But it has all the basic principles of a gun.

Take a mouthful of dried peas. Put the long thin tube of the peashooter to your lips, roll a pea into the shooter with your tongue and blow. That's all there is to it.

What happened?

When you blew into the tube, you built up a gas pressure behind the pea. The compressed gas has to go somewhere. It can't go back into your mouth because that's where the pressure is coming from. It presses against the sides of the tube, but they are unyielding. Also it presses against the pea. The pea can move, so the gas EXPANDS against it—forcing it out of the tube at high speed.

This time take a heavier tube, closed at one end except for a small hole containing a fuse. Pour some gunpowder down into the closed end of the tube, and slide a bullet in on top of the gunpowder.

Now touch off the gunpowder by lighting the fuse. Almost instantly, the powder burns and is changed to a gas under high pressure. The gas wants to expand. It pushes, as before, against the sides of the tube. But, unless the tube breaks, the gas can't get out that way. It presses against the closed rear end of the tube. The whole tube is pushed backward—that is what makes a gun KICK.

But you're holding on to the tube, and it can't move back very far. So most of the pressure of the gas pushes against the bullet. The bullet can move, and the expanding gas shoots it out of the tube.

Recognize this tube? It's the old MUZZLE LOADER—a gun that was the mainstay of the world's fighting men until the middle of the last century.

To make this old blunderbuss into a modern gun that can be loaded conveniently from the breech end, you only need some way of opening and closing the rear end of the tube. You need a removable BREECH PLUG that can be locked in place when the gun is fired—and can be unlocked and opened to reload the gun. In modern small arms, the breech plug is usually called the BOLT.

One big advantage of the BREECH-LOADING gun is that you can forget the old powder horn and use CARTRIDGE ammunition. The breech end of the barrel is widened a bit, to form a CHAMBER. Into this chamber you can slip a metal or paper cartridge containing a bullet and a measured quantity of explosive. Then close and lock the breech plug.

One big question remains. How are you going to explode the propelling charge in the cartridge? There are several ways of doing this, but all modern small arms are fired by PERCUSSION. At the rear end of the cartridge is a small charge of very sensitive explosive, known as a PRIMER. This is so sensitive that it will explode if struck. A FIRING PIN or STRIKER is arranged so that it can be driven against the primer when you want to fire the gun.

The firing pin is always driven by a spring. Sometimes the spring is connected directly to the pin. Sometimes a separate piece, the HAMMER, is driven forward by the spring and hits the firing pin, driving it forward.

When the gun is ready to fire, the firing pin or hammer must be held back, compressing the spring. That is, the gun must be COCKED. The gun is held cocked by a small hooked piece, known as the SEAR. When you pull the TRIGGER, the sear is permitted to move, releasing the cocked firing pin or the hammer. The firing pin drives forward, hits the primer, and fires the gun.

A MANUALLY-OPERATED GUN

Now that you know some of the important things which go on in any gun, look at figure 1 which shows a typical rifle—the old reliable Springfield, officially known as the rifle, M 1903 caliber .30.

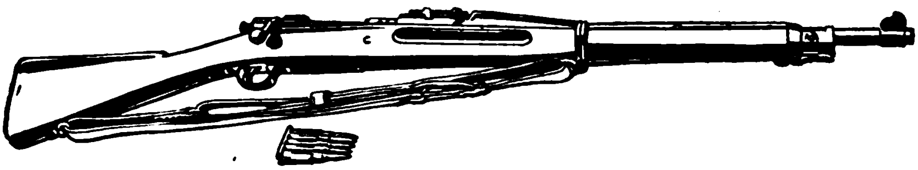


Figure 1.—Springfield rifle, caliber 30, M 1903.

The wooden part of the rifle—called the STOCK—has nothing to do with the actual operation of the piece. It just gives you something to hold on to. The after end of the stock is called the BUTT and the forward end is called the FORE-END. On most military rifles, the stock extends over a part of the barrel to protect the rifleman's hand from being scorched by the hot metal.

The operating parts of the rifle fall into three main groups—the BARREL, the RECEIVER, and the ACTION.

The RECEIVER is simply the chassis. The stock is fastened to it. The barrel is screwed into it. And it contains the action.

You already know that the BARREL is the tube out of which the bullet shoots. The hole through the length of the barrel is called the BORE—for the very good reason that this hole is bored through a

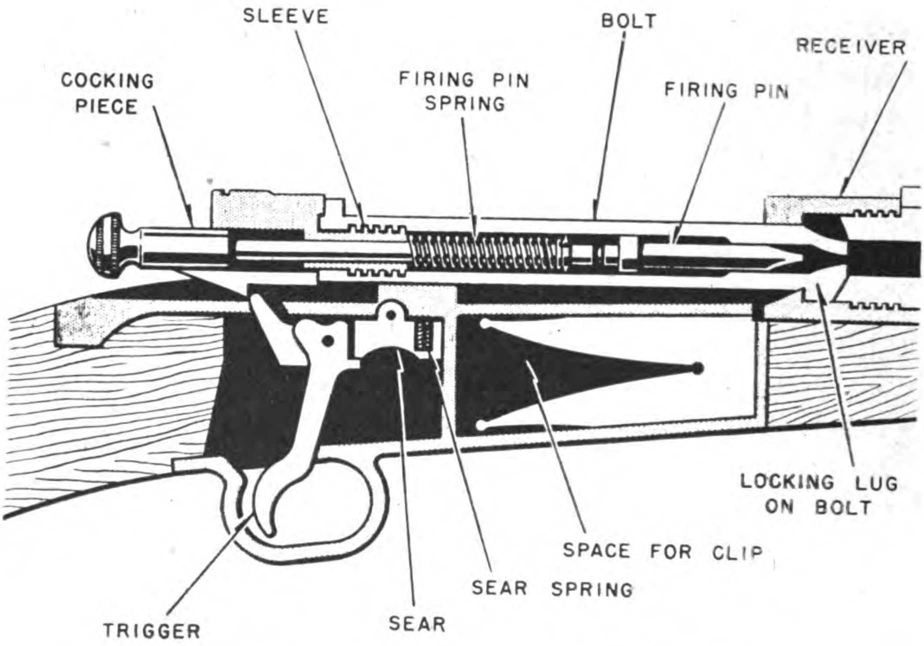


Figure 2.—Operating principle of the Springfield rifle.

solid piece of steel to make the barrel. After the tube has been bored, spiral GROOVES are cut into the walls of the barrel to form the RIFLING. The ridges left between the grooves are called the LANDS.

The barrel is rifled in order to make the bullet SPIN. It has been found that a spinning bullet follows a truer course.

The diameter of the bore before it is rifled determines the caliber of the rifle. Caliber is measured in decimals of an inch.

The bore diameter of a SHOTGUN is expressed differently—in GAGE, as 12-gage, or 16-gage. Shot-

guns are smooth-bore weapons with no rifling. The gage number represents the number of lead balls—of nearly the same diameter as the bore of the gun—required to weigh a pound. The smaller the bore, the more balls required, so a 16-gage gun is smaller in bore than a 12-gage.

The bore of foreign guns, or of guns adopted from foreign designs, is usually expressed in MILLIMETERS. Since 1 inch equals 25.4 mm, you can easily figure out for yourself the caliber of a 20-mm, a 37-mm, or a 75-mm gun.

As the name implies, most of the moving parts of the gun are included in the ACTION. These parts are shown in figure 2.

The BOLT is a sliding piece which moves back and forth inside the receiver. In itself it serves as a breech plug, and it also carries the FIRING PIN, the FIRING PIN SPRING, and the EXTRACTOR. The extractor is a little clawlike arm which is attached to the side of the bolt at the front. The extractor clips over the flange of the cartridge and pulls it out of the chamber when the bolt is drawn back.

Since the bolt is a breech plug, it must be LOCKED into the closed position when the rifle is fired. Two projecting lugs on the forward end of the bolt lock it in the closed position by engaging with matching slots on the receiver. At the rear of the bolt is a piece, called the SLEEVE, which is loosely threaded into the end of the bolt so that it can be easily screwed in and out. The end of the firing pin projects through the center of the sleeve and is connected to the COCKING PIECE. Notice in figure 2 that the cocking piece has a hook-shaped projection at the bottom.

The TRIGGER, as you know, is what releases the cocked firing pin and fires the piece. The TRIGGER GUARD protects the trigger against accidental blows.

The MAGAZINE is a compartment for additional

cartridges. As each cartridge is fired, and the empty case ejected, spring pressure against the FOLLOWER in the magazine pushes a new cartridge into position to be fed into the chamber.

Now you are ready to see what happens when the rifle is operated. Suppose there is a loaded cartridge in the chamber, the bolt is locked in place, and the firing pin has just struck the cartridge.

The primer explodes and sets off the propelling charge of smokeless powder. The powder is immediately converted into a gas under high pressure which pushes forward against the bullet and backward against the base of the cartridge. The forward pressure starts the bullet out of the gun and continues driving it as long as it is in the barrel. The backward pressure against the cartridge base drives the cartridge against the face of the bolt and tries to push it backward.

The bolt, however, is locked to the receiver by its projecting lug. Also, the cartridge case expands against the wall of the chamber and sticks firmly. So instead of sliding back, the bolt drives the whole rifle back against your shoulder. This is the kick or RECOIL.

Now the bullet has left the barrel and you want to prepare for another shot. Take hold of the bolt handle and swing it upward, as far as it will go, rotating the bolt about a quarter-turn. During the first part of this rotation, the locking lug on the forward part of the bolt is turned out of the matching slot in the receiver. This unlocks the bolt. As the bolt continues to rotate, another lug on the bolt presses against a slanting groove on the receiver so that the bolt is forced slightly to the rear with a strong leverage. This is called a CAMMING action, and the groove is called the CAM surface. This slight rearward motion provides a powerful pull so that the extractor, which is hooked over the edge

of the cartridge case, can start the case out of the chamber.

The SLEEVE at the rear is keyed to the receiver to prevent it from rotating, so during this movement it is not turning. Therefore, since the sleeve is threaded to the bolt, the sleeve is cranked backward as the bolt turns—pulling the cocking piece and the firing pin with it and compressing the firing pin spring. When the bolt handle has been pushed all the way up, the cocking piece has moved far enough back so that the hook on the under side is caught by the sear. The firing pin is now cocked.

Thus you see that it is possible to cock the Springfield merely by rotating the bolt handle upward and then down again.

To eject the cartridge case, pull back on the bolt handle. The bolt, sleeve, and cocking piece all slide backward, and the cartridge case, which is grasped at one edge by the extractor, comes back with the bolt.

As the bolt is drawn back, a lengthwise slot at the front of the bolt comes opposite the EJECTOR. This is a small pivoted arm fastened to the receiver. When the slot comes opposite it, a spring forces the ejector out into the slot. Then as the bolt is drawn back and the cartridge case emerges from the chamber, the edge of the case opposite the extractor hits the ejector. The sharp blow forces the case to pivot around the extractor and throws it out the side of the rifle.

As the bolt is drawn further back it moves past the top of the magazine. Just as the bolt reaches the end of its travel, it clears the magazine and the magazine spring forces a new cartridge up in front of the bolt.

Now push the bolt handle—and the bolt—forward again as far as it will go. This forces the fresh cartridge into the chamber.

Finally, rotate the bolt handle downward. Dur-

ing the first part of this movement, the camming lug on the bolt engages the camming slot and forces the bolt firmly home. Then the locking lug on the bolt engages the matching slot on the receiver and the bolt is locked.

During this rotation of the bolt, the sleeve is cranked forward, but the cocking piece is hooked over the sear so it stays behind in the cocked position.

Now pull the trigger. (Make sure you have the rifle pointed toward a target.)

The pivot point of the TRIGGER, as you can see in figure 2, is fastened to the SEAR. The upper edge of the trigger rolls against a bearing surface on the receiver and forces the trigger downward, pulling the sear with it. When the sear has pushed far enough down, it lets go of the hook on the cocking piece—and the firing pin jumps forward, impelled by its spring. The rifle fires.

An automatic safety feature prevents the gun from firing at any time when the bolt is not locked. If the bolt has not been rotated into the locked position, the cocking piece hits against a cam surface on the bolt, and the firing pin is not able to reach the cartridge. The force of the firing pin spring is used to rotate the bolt into the fully locked position. When this happens, a misfire results. Then it is only necessary to rotate the bolt handle upward and back down again to re-cock the piece. Then the rifle should fire.

There are two settings to be made on the Springfield—the SAFETY and the MAGAZINE CUTOFF. The safety is a thumb lock on the rear end of the bolt. When the rifle is cocked, this thumb piece can be moved over to the right into the safe position. In this position, it locks the firing pin to the bolt and thus positively prevents the firing pin from moving forward and firing the cartridge.

The magazine cutoff lever on the left side of the

receiver sets the rifle to operate either as a repeating rifle or a single shot. When the cutoff is set to the "on" position, the rifle operates as previously described. When the lever is in the "off" position, the bolt is prevented from coming all the way back. It does not come far enough back to get past the magazine. Therefore, cartridges in the magazine are held down by the forward end of the bolt and cannot rise into the action. To load the piece you have to insert a fresh cartridge by hand from above.

When the cutoff lever is set midway between the "off" and "on" positions, the bolt may be drawn all the way out of the receiver for disassembling the rifle.

KINDS OF AUTOMATIC OPERATION

Recall what you did when you operated the Springfield.

You unlocked the bolt.
You extracted and ejected the cartridge.
You cocked the firing pin.
You rammed home a fresh cartridge and relocked the bolt.
You released the cocked firing pin and fired the rifle.

Doing all these things by hand takes time and slows the rate at which you can fire. If you could make the rifle itself do the work, it would speed things up immensely.

You know that there is plenty of extra power in a gun besides what is needed to drive the bullet forward. You know it from the way your shoulder gets sore from the kick of a rifle. That kick represents wasted energy that could have been used to operate the gun.

It doesn't take very long to pull the trigger. What takes up time is operating the bolt. If you could arrange to have the extra power of the gun

do this part of the work, you would have a semi-automatic weapon. A SEMI-AUTOMATIC gun unlocks, extracts, cocks, reloads and relocks automatically. All you have to do is pull the trigger.

Of course, this makes the gun more complicated and harder to keep in order.

A FULLY AUTOMATIC gun keeps firing as long as you hold the trigger back. Machine guns and submachine guns are fully automatic.

There are three main ways in which the waste power of the cartridge can be used to operate the gun—GAS PRESSURE, RECOIL, and BLOWBACK.

In a GAS-OPERATED gun, a small hole is cut into the barrel. When the bullet has passed the hole, some of the compressed gas behind the bullet escapes through the hole. It is led into a cylinder where it drives a piston. The force of the moving piston is used to operate the action.

In a RECOIL operated gun, the backward thrust, or kick, of the barrel and bolt, which are locked together, is used to do the work.

In BLOWBACK guns, the bolt is driven backward by the pressure of the expanding gases in the chamber. In such a gun, the bolt must be kept in position, closing the breech of the gun, while the gas pressure is high—but, after the bullet has nearly left the barrel, the bolt can be allowed to drive back. Its backward movement does the work.

A GAS-OPERATED GUN

A semi-automatic weapon which very closely resembles the Springfield in its action is the new WINCHESTER CARBINE which is now being issued as a substitute for side-arms. This is a gas-operated gun.

The action of the Winchester Carbine differs from the Springfield in the way the firing pin works. In the carbine, the firing pin does not have

a spring. Instead, a pivoted HAMMER is connected to the receiver. The hammer has a spring to swing it around against the end of the firing pin. When the BOLT moves backward, it rides over the hammer and pushes it down. The SEAR, as you can see in figure 3, catches against a notch on the hammer and holds it down, in the cocked position. When the TRIGGER is pulled, it pushes up the after end of the sear, causing the sear to pivot on its pin and release the hammer. The hammer flies up and strikes the firing pin, driving it forward.

Notice the slot in the sear where it fits over the pivot pin. This is to permit it to hold the hammer cocked even though you should still be holding the trigger back. The sear spring (not shown) pushes the sear forward as well as up. In this position, its after end does not engage the trigger. When the trigger is released, the hammer spring forces the sear backward, so that its after end rides on to the trigger, ready to be pushed up when the trigger is pulled again.

The big feature of the carbine is that you do not have to work the action by hand as you do in the Springfield. The rifle itself does the work by gas pressure.

To accomplish this, a new part is added—the SLIDE. This piece fits around the fore part of the bolt and can slide back and forth guided by slots in the receiver. At its forward end, the slide terminates in a chamber which fits around the end of a CYLINDER under the barrel of the rifle.

The slide is held forward by a strong spring known as the OPERATING SPRING.

When the carbine is fired, and the bullet has traveled about half way down the barrel, a small PORT or hole in the side of the barrel is uncovered. Part of the compressed gases behind the bullet rush through this hole into the cylinder. There they deliver a sharp blow against the forward end

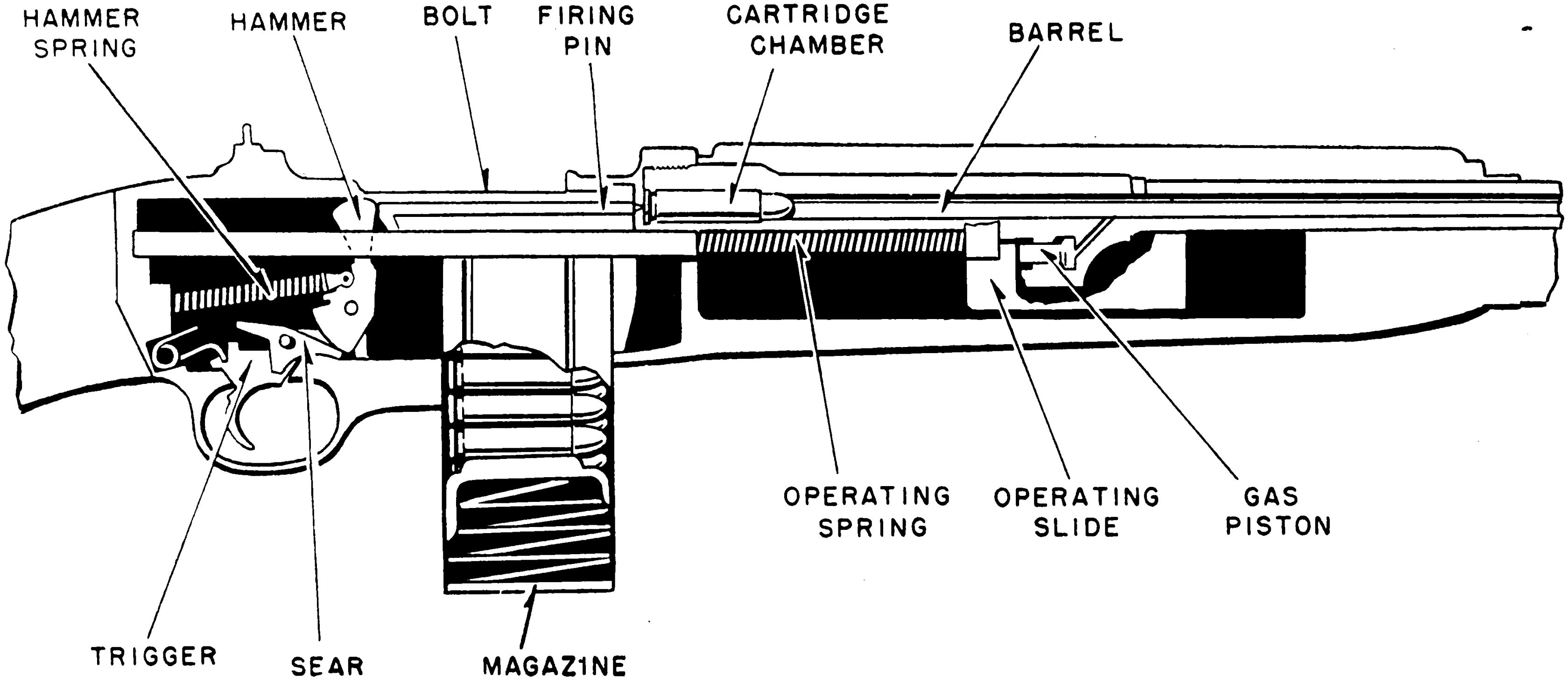


Figure 3.—Principle of operation of the Winchester Carbine, caliber .30, M2.

of the slide. This blow drives the slide backward, compressing the operating spring.

The bolt of the carbine does not have a handle on it like the one on the Springfield. Instead there is simply a small operating LUG which fits into a matching SLOT in the slide. This slot is straight for about $3/8$ inch and then turns upward. Thus, when the slide moves backward, the lug slides along the straight portion of the slot. Then, as the lug is forced up the slanting part of the slot, the bolt is forced to rotate. When the bolt has rotated about a quarter turn the lug comes to the top of the slot. As the slide moves further forward the bolt is thus driven to the rear with the slide.

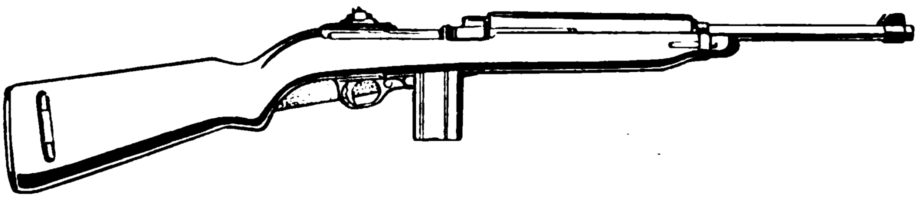


Figure 4.—The Winchester Carbine.

You can see that by this CAMMING action the slide has done exactly the same thing to the bolt that your hand did to the bolt of the Springfield—first rotated it to unlock it, and then pushed it backward, extracting and ejecting the old cartridge, cocking the hammer and permitting a new cartridge to come up from the magazine into the action.

MOMENTUM USED

By now the momentum given to the slide by the impact of gas in the piston has been used up. The compressed operating spring drives the slide forward—pulling the bolt with it and ramming the fresh cartridge into the chamber. During the last part of the forward movement of the slide, the

slanting slot cams the bolt's operating lug downward, thus rotating the bolt into the locked position.

The carbine is now ready to fire again as soon as the trigger is pulled.

Thus, to load and fire this semi-automatic weapon, it is only necessary to pull the operating slide back once by hand to get the first cartridge into the chamber. There is a hook on the slide by which to pull it. Then you need only pull the trigger for each shot until the 15-round magazine has been emptied.

A RECOIL-OPERATED GUN

For a typical recoil-operated semi-automatic gun look at figure 5, a picture of the standard military model .45 caliber AUTOMATIC PISTOL. Although this pistol is called an automatic, it is actually a semi-automatic. You have to pull the trigger each time the gun is fired, but the gun does the rest of the work.

Figure 5.—Automatic pistol, caliber .45, M 1911.

The main force employed to empty, cock, and re-

load the RECOIL-OPERATED .45 caliber automatic is the backward thrust of the compressed gases on the bolt during the period that the bolt and barrel are LOCKED together. Therefore, the barrel must

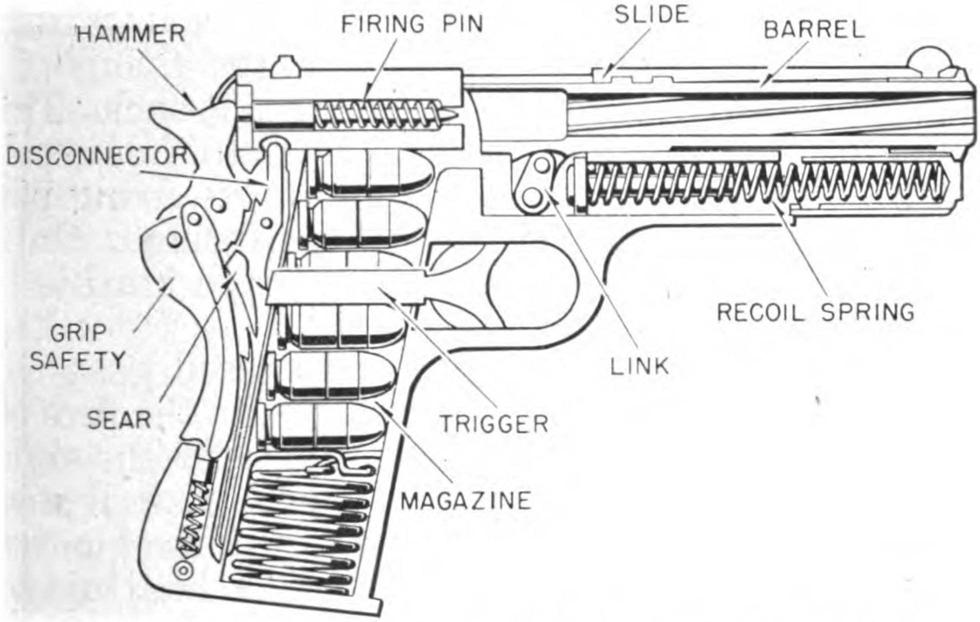


Figure 6.—Principle of operation of the Colt automatic pistol.

be mounted in the receiver so that it can move backward and forward. If you look at figure 6, you will see that this is indeed the case. The barrel slides in a trough in the receiver and is fastened to it only by the LINK. This is a short bar pivoted to the receiver at one end and to the barrel at the other.

The bolt in the automatic pistol is shaped differently from that of the rifles you have studied so far —it's so different in shape that it isn't even called a bolt. It is called the SLIDE. The breech plug portion of the slide has a long forward projection which extends out over the full length of the barrel. The slide, in fact, forms the outer cover of the pistol at the top.

Just as in the Springfield and the carbine, the breech plug, or slide, must be locked to the barrel

when the gun is fired. In this case the locking is accomplished by the two projecting RIBS on the top of the barrel, which fit into matching slots on the underside of the slide.

As in the case of the carbine, the firing pin of the automatic pistol is driven forward by a HAMMER. The spring which you see around the firing pin does NOT drive it forward, but it pulls it back. The firing pin of this weapon is shorter than the breech block. If the hammer is lowered on the firing pin gently, the pin will not touch the cartridge. Only when the hammer strikes the firing pin hard is it driven forward by its momentum.

When the pistol fires, the compressed gases in the barrel exert a backward pressure on the face of the breech block portion of the slide. So the slide moves backward, pulling the barrel with it and compressing the recoil spring. As the barrel moves back, the link pivots. After the link has turned about 45°, it begins to pull the barrel downward, freeing the locking ribs from the slots in the slide. The breech is now UNLOCKED. But by this time the bullet has left the barrel, the chamber pressure has dropped, and it is perfectly safe to unlock the breech.

The barrel moves no further. But momentum makes the slide continue backward, further compressing the RECOIL SPRING. As it moves, the slide extracts and ejects the spent cartridge in the same manner as on the guns already studied. The slide also rides over the HAMMER and cocks it.

When the slide has moved far enough back to uncover the MAGAZINE, which is located in the handle of the pistol, the magazine spring forces a fresh cartridge up in front of the slide.

Now the recoil spring pushes the slide forward again. The slide rams the fresh cartridge into the chamber. Then it pushes the barrel forward, pivoting the link.

This lifts the barrel, so that the locking ribs engage the slots in the slide.

The chamber is now closed and locked, and the gun is ready to fire. The hammer is held back by the SEAR, which hooks into a notch in its lower portion.

When you fire the pistol, the forked horizontal extension of the trigger pushes against the lower portion of the sear, pivoting it and releasing the hammer.

In the drawing of the sear-hammer linkage you have probably noticed an unfamiliar piece, the DISCONNECTOR. This is a safety device to prevent the gun from firing before the breech is locked. When the slide is back from the BATTERY—or ready-to-fire—position—the disconnector is pushed down and locks the sear in the cocked position. Then it is impossible for the trigger to pivot the sear. When the slide is in battery, a cavity on the underside of the slide comes opposite the disconnector and permits it to jump up, releasing the sear.

If the disconnector on the automatic becomes worn, the pistol will sometimes fire several shots on one pull of the trigger. This is dangerous, because the breech may not be fully locked at the second shot.

A further safety feature is the GRIP SAFETY. This is a portion of the back of the handle which is pivoted and spring loaded. Unless your hand is around the grip of the pistol, the grip safety will spring outward, locking the trigger.

The automatic also has a SAFETY LOCK mounted on the side of the receiver. When it is pushed upward, it locks the sear and hammer in the full cocked position.

A BLOWBACK-OPERATED GUN

BLOWBACK is the simplest principle upon which an automatic gun can work. In a blowback weapon,

the breech plug or bolt is not locked to the barrel. When the powder charge explodes, the bullet is driven forward and, at the same time, the bolt is driven backward, opening the breech.

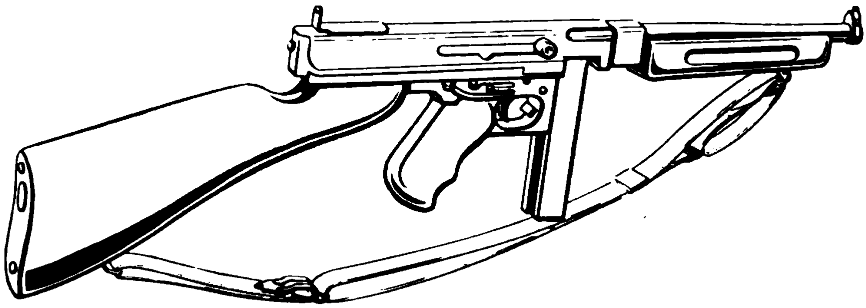


Figure 7.—The Thompson sub-machine gun M1.

Obviously, if the breech opened at the very instant the bullet started forward, the gun would lose most of its power—and the gunner would be badly burned. So you will find that in a blowback gun the bolt is made fairly heavy and the recoil spring quite strong. Since the bolt is heavier than the bullet and is held in place by a spring, it begins moving much more slowly than the bullet does. By the time the breech has opened, the bullet is most of the way out of the gun, and the chamber pressure has dropped to a safe level.

In some guns, such as the Reising sub-machine gun, and older models of the Thompson sub-machine gun, you will find that the movement of the bolt is still further delayed by partial locking. Usually the bolt, or some lug on it, has to climb a steeply inclined surface. While the chamber pressure is high, the friction against this slanting surface is very great, and the bolt moves slowly if at all. When the pressure drops, the friction drops, and the bolt is able to climb the inclined surface and move backward.

You will usually find that a gun operated by blowback uses the comparatively low power .45 caliber pistol ammunition. It would be dangerous

to use high-powered rifle ammunition in a gun with an unlocked breech.

As an example of a blowback gun, consider the THOMPSON .45 M1A1 SUB-MACHINE GUN — the famous Tommy-gun, or Typewriter—depending on which gangster movie you saw.

The Thompson sub-machine gun can be set to operate as a SEMI-AUTOMATIC gun— firing once for each pull of the trigger—or as a FULL AUTOMATIC weapon. As an automatic gun, the Thompson will keep firing, at a rate of 600 to 700 rounds per minute, as long as you hold the trigger—or until the magazine is empty. The most commonly used magazine is the BOX type containing 20 or 30 rounds, but a DRUM magazine containing 50 rounds is also available. Obviously, you can't fire the Tommy gun for very many seconds as a fully automatic weapon. It is fired in short BURSTS.

Find the BOLT in figure 8. Notice how big it is. It consists of a rectangular after-section attached to a rounded forward portion which forms the actual breech plug and carries the firing pin.

The firing device on this gun is different from those you have run into before. The HAMMER is a triangular pivoted piece located at the forward end of the rectangular portion of the bolt. The hammer is not driven by any spring. Rather, when the bolt is pushed forward by the recoil spring, the lowermost part of the hammer hits against the receiver. This causes the hammer to pivot sharply and its upper edge hits the after-end of the firing pin, driving it forward into the cartridge.

You can see that the Thompson gun must fire whenever the bolt moves forward and closes the breech. Therefore, when the gun is not firing, the bolt must be held back. In this gun, the function of the SEAR is to hold the bolt back—not, as in the other guns studied, to hold the firing pin cocked.

The drawing shows the gun at the moment when

the cartridge has just fired and the recoil is taking place. Assume that the gun is set for full automatic fire. As the bullet moves down the barrel, the heavy bolt gets into motion slowly, pushed back by the expanding gas in the chamber. Finally, it gets going and is thrown backward, compressing the recoil spring. The spent cartridge case is forced out of the chamber by the gas pressure. It is hooked to the face of the bolt by the extractor and therefore rides backward till one edge strikes the ejector, and it is thrown clear of the gun.

By the time the bolt gets all the way back, the RECOIL SPRING has absorbed most of its energy, and the bolt strikes fairly lightly against the buffer at the rear.

If the trigger is not being held, the sear will spring upward and catch in the NOTCH on the underside of the bolt at the forward end of the rectangular portion. The action stops at this point.

Now, if you pull the TRIGGER the sear will be pushed down. The recoil spring drives the bolt forward, picks up the fresh cartridge which has been pushed up into the action by the MAGAZINE SPRING and rams it into the chamber. As the bolt comes all the way forward, the hammer strikes against the receiver, pivots, and drives the firing pin into the cartridge, firing the gun.

The bolt is driven back again by the explosion. If you are still holding the trigger, the sear will remain down, and the bolt will be driven forward immediately by the recoil spring, firing another shot. In this manner the gun will continue to fire as long as the trigger is held.

To understand how the gun operates as a SEMI-AUTOMATIC weapon, you have to examine the drawing of the trigger linkage carefully. The TRIGGER, you note, is pivoted near its top to the receiver. Pivoted to the trigger itself is the DISCONNECTOR, a V-shaped piece with a small spring

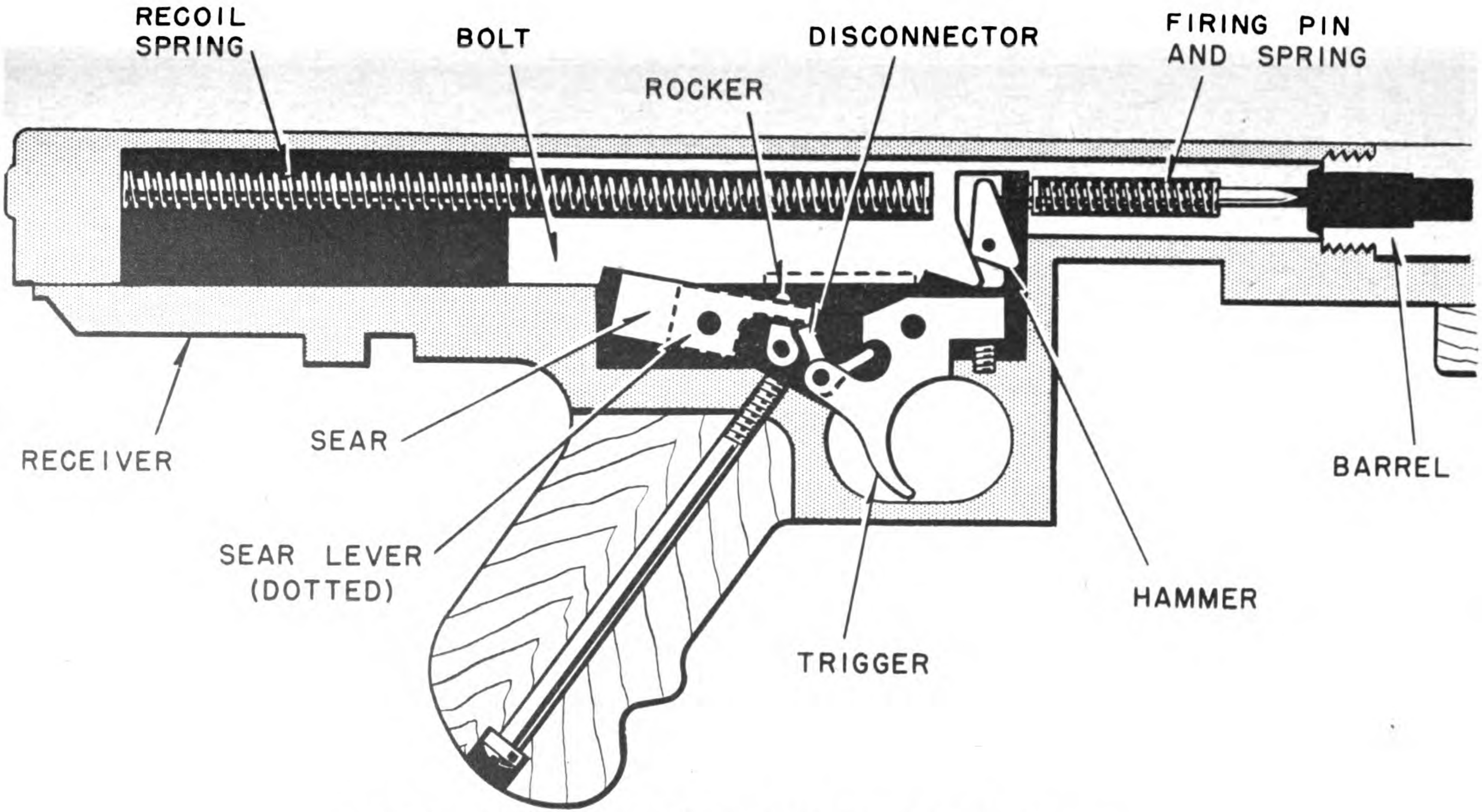


Figure 8.—Principle of operation of the Thompson sub-machine gun.

which holds it in position. The rearmost arm of the V bears against the flat spot on the SEAR LEVER. This is a lever pivoted to the receiver. Back of the sear lever, and bearing against it, is the SEAR. When the trigger is pulled, the disconnector is forced against the sear lever and rotates it, pulling the sear down to release it from the notch on the bolt.

Alongside the sear lever is another small lever, the ROCKER. This is pivoted about an oval-shaped pin which comes out through the side of the receiver and is connected to the FIRE CONTROL LEVER. When the fire control lever is set for auto fire, the rocker is pulled down out of the boltway and has no effect. The sear is held down at all times when the trigger is held back.

If, however, the fire control lever is set to SEMI-AUTO fire, the rotation of the oval pivot forces the rocker up into the boltway where it fits into a slot in the bolt.

Now, when the gun is fired, the bolt moves back. The end of the slot hits the rocker and tilts it over. This movement causes the rocker to knock the disconnector forward, compressing the disconnector spring. The disconnector is knocked out of contact with the sear lever. This frees the sear lever and sear, and the sear spring forces the sear up into the boltway where it catches the bolt in its retracted position and prevents further fire.

Thus, in semi-auto fire, the gun will fire only one shot at a time, even though the trigger is held back.

You have now seen an example of the operation of each of the four basic types of small arms—manually operated, gas-operated, recoil-operated, and blowback-operated. The Naval air arm uses many types of small arms, and as an Aviation Ordnanceman you should become familiar with them. Although particular ones have been used to

demonstrate the four basic types of operations, you'll find a complete resume of all the small arms in the following paragraphs.

RIFLES

SPRINGFIELD RIFLE caliber .30-M1903 is a manually-operated repeating rifle which may be set for single shot operation by means of a magazine cut-off. The magazine holds five .30 caliber cartridges of either M1 or M2 type. This ammunition provides a muzzle velocity of about 2,700 feet per second. The rifle is three feet 7¼ inches long and weighs 8.69 pounds without bayonet. The effective range is up to 600 yards. The action is of the rotating bolt type.

The Springfield was the standard military rifle of the United States until the Army began replacing it with the Garand M1 rifle, a gas-operated semi-automatic. The Springfield has an elaborate and widely adjustable set of sights which has made it a favorite with snipers and given it the reputation of being the most accurate military rifle in the world.

ENFIELD RIFLE, caliber .30 M1917 is a five-shot repeating rifle developed from a British design during the first World War to supplement the then limited supply of Springfields. Large numbers were manufactured and many are still in use. The Enfield takes the same ammunition as the Springfield and has the same general performance characteristics. However, it does not have the long-range accuracy of the Springfield. The Enfield has a rotating bolt of the same general type as that of the Springfield.

WINCHESTER CARBINE caliber .30, M1 is a semi-automatic gas-operated weapon used as a substitute for side arms. The Winchester uses the .30 caliber carbine-cartridge M1. This has a smaller propelling charge than the rifle cartridge and pro-

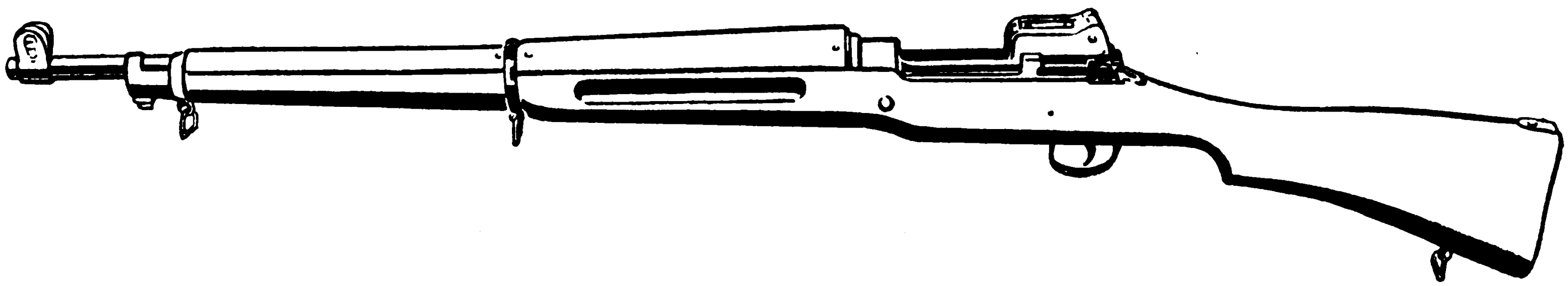


Figure 9.—Enfield rifle, caliber .30, M1917.

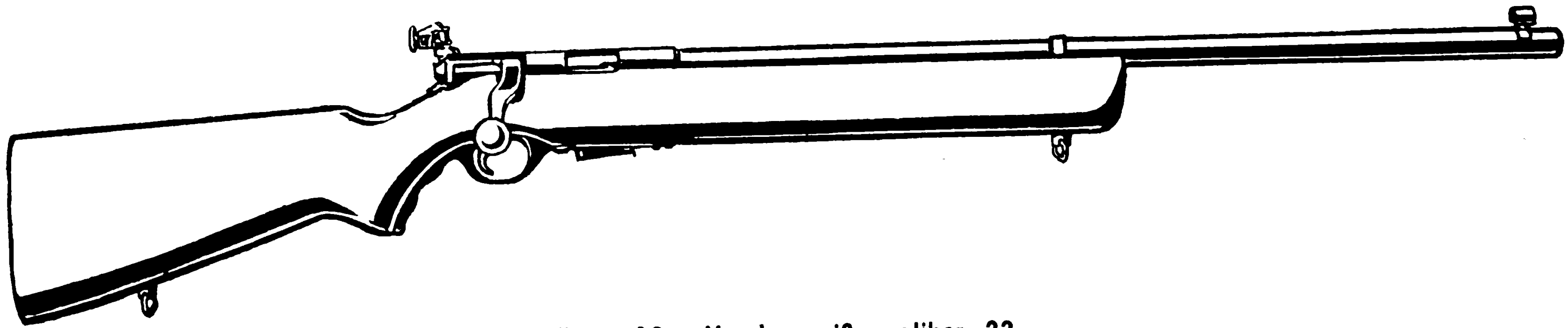


Figure 10.—Mossberg rifle, caliber .22.

vides a muzzle velocity of only 1,900 feet per second. The carbine has an accurate range of about 300 yards. The magazine contains 15 rounds, and the gun weighs about 5.75 pounds.

MOSSBERG RIFLE, caliber .22, Model 44US is a training weapon used for marksmanship practice. It is a bolt action repeating rifle carrying a 7-ROUND ~~pound~~ detachable clip. It weighs 8.25 pounds.

Various types of commercially manufactured SHOTGUNS are frequently used for guard duty around industrial plants and Naval installations. The shotgun is a useful weapon for the short range work encountered in this type of duty because the spread of shot makes it easier to hit the target. The large 12-gage shotgun is preferred for this work—usually loaded with No. 0 buckshot. Both pump-action repeaters and semi-auto loaders are used.

HAND GUNS

COLT AUTOMATIC PISTOL caliber .45 is the standard military side arms. It is a recoil-operated semi-automatic weapon. The magazine, located in the handle, carries seven .45 caliber cartridges. This pistol throws a large bullet but has the comparatively low muzzle velocity of 810 feet per second. It has an accurate range of 75 yards and a maximum range, elevated to 30°, of about 1,600 yards. The pistol is 8½ inches long and weighs 39 ounces. Safety features include — the grip safety, which prevents the weapon from being fired unless it is held firmly in the hand; a thumb safety, by which the cocked pistol can be locked in a safe position, and the disconnector, which automatically prevents the pistol from being fired before the breech is locked. A convenient feature in the design insures that when the last shot is fired from the magazine the slide will stop in an open position. This makes it unnecessary to pull

back the slide by hand when loading a fresh magazine.

Figure 11.—Smith & Wesson revolver, caliber .38, military and police special.

SMITH & WESSON REVOLVER caliber .38 is a smaller-caliber and slightly lighter (29 ounces)

Figure 12.—Colt Ace automatic pistol, caliber .22.

pistol. It is issued only for use by certain aviation flight crews. It's a manually-operated repeating

weapon. A revolving cylinder with six chambers for .38 caliber cartridges forms the chamber of the gun. The gun is usually operated by pulling back the hammer with the thumb, an action which cocks the hammer and also rotates the cylinder to bring a fresh cartridge opposite the barrel. A pull on the trigger then releases the hammer.

The same action can be obtained entirely by pulling the trigger. In this case, the first part of the trigger movement cocks the hammer and rotates the cylinder. The latter part of the pull fires

Figure 13.—Hi Standard automatic pistol, caliber .22, Model B.

the gun. After all shots have been fired, the cylinder is swung out of the frame, and a push on the ejector rod ejects all cartridges.

COLT ACE PISTOL caliber .22 is a training pistol designed to take the .22 long rifle ammunition. It is mounted on the frame of a .45 automatic and has a breech specially designed to step up the kick to make it similar to that of a .45. The magazine holds 10 cartridges, and the pistol has a recoil-operated semi-automatic action essentially the same as that of its big brother, the .45.

HI STANDARD PISTOL caliber .22 is another semi-automatic training pistol employing .22 long rifle ammunition. The magazine holds 10 rounds.

THOMPSON SUB-MACHINE GUN caliber .45 M1A1 can be operated either as a semi-automatic or full-automatic. Blowback operated, it develops a cyclic rate of fire in full-automatic operation of 600 to 700 rounds per minute. Its box-type magazine contains 20 to 30 rounds or the drum magazine contains 50. The .45 caliber pistol ammunition develops a muzzle velocity of about 950 feet per second, giving the gun an accurate range of about 300 yards. The gun is about 33 inches long and weighs, without magazine, 9 pounds 13 ounces.

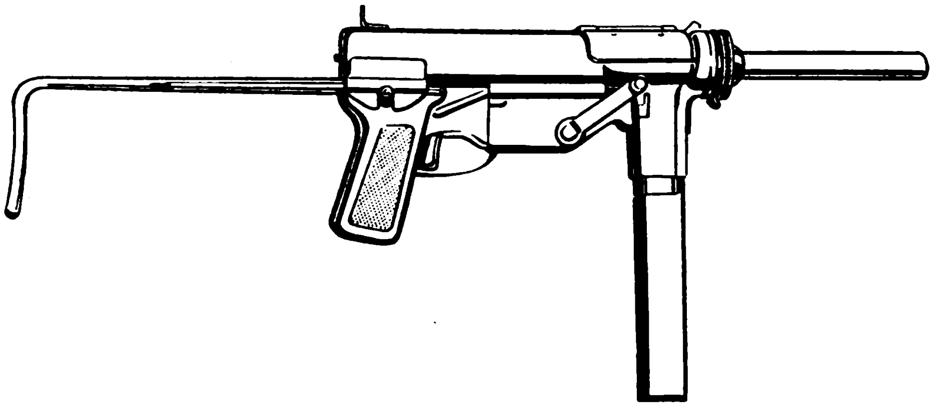


Figure 14.—Sub-machine gun, caliber .45, M3.

SUB-MACHINE GUN caliber .45 M3—a new design of sub-machine gun, much simpler, cheaper, and lighter than the THOMPSON. It uses the same .45 caliber ammunition—in a 30-round box magazine—and has about the same ballistics as the Thompson. However, the gun weighs only about 6 pounds. The M3 can be fired full-automatic only. It has a rate of fire of 450 rounds per minute. This comparatively slow rate of fire is intentional, since it is considered more economical of ammunition. The gun is blowback-operated.

BROWNING AUTOMATIC RIFLE caliber .30 M1918—actually a light machine gun or machine rifle. It is known as the BAR. Unlike the sub-machine guns, it is gas-operated with a locked breech.

Therefore, it is able to use the powerful M1 rifle ammunition. This ammunition gives it a muzzle velocity of about 2,680 feet per second and an accurate range of about 600 yards. The cartridges are carried in a detachable box type magazine

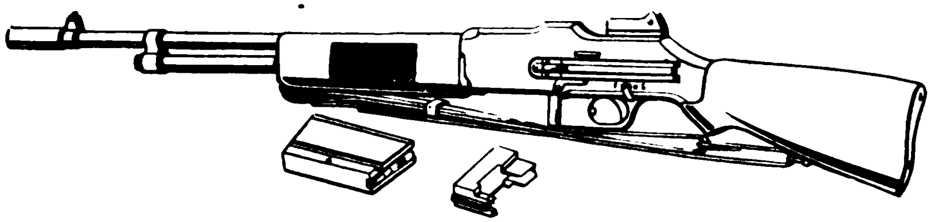


Figure 15.—Browning automatic rifle, caliber .30, M1918.

holding 20 cartridges in a staggered line. The gun is 47 inches long and weighs 15.5 pounds without magazine. Set for full-automatic, the BAR will fire at a rate of about 500 rounds per minute, but it is normally used semi-automatic, firing 40 to 60 shots per minute.

CHAPTER 3

BROWNING MACHINE GUNS

BIG BROTHER AND LITTLE BROTHER

As an Aviation Ordnanceman, you need a general familiarity with all types of small arms and automatic guns up to the 37 mm aircraft guns—and even the 75 mm, which is now being mounted in some airplanes. And you will need a really intimate knowledge of the particular guns used in your squadron. But there are two guns that you must know—wherever you are. These are the .50 and .30 caliber BROWNING AIRCRAFT MACHINE GUNS—usually known as BAM guns. Except for training craft, there is hardly an airplane in the Navy which doesn't mount one or both of these types. They are the main offensive weapons of the fighters and the defensive weapons of the bombing planes.

Fortunately for you, the two guns are very similar. Except for a few details of construction, the caliber .30 is a little brother of the caliber .50.

Both guns are RECOIL-OPERATED, fully automatic weapons. They can not normally be set for semiautomatic fire. You can see how they look in figure 16. Notice that neither has a magazine. Unlike the automatic weapons studied in the last chapter,

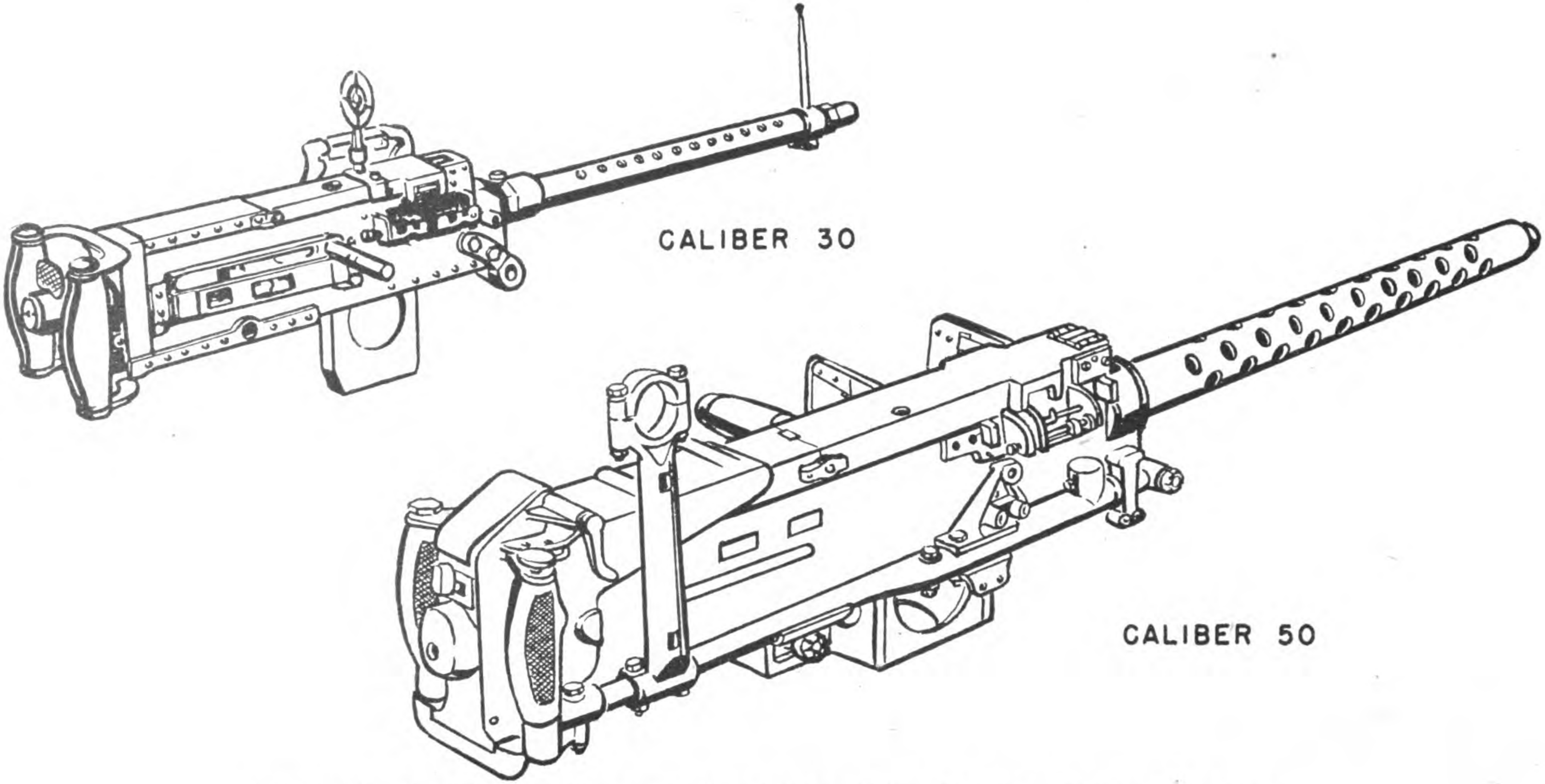


Figure 16.—Browning machine guns, aircraft M2. Caliber .30, top. Caliber .50, bottom.

these guns are BELT-FED. The cartridges are fastened together by metal LINKS that form a belt of any convenient length. The mechanism of the gun pulls the belt forward, extracts the cartridges from the belt, and discards the connecting links. This is known as a DISINTEGRATING type of belt. On older models of the Browning machine gun—and some types still used on the ground—the cartridges are slipped into loops on a WEB belt, but the principle of operation is the same.

The caliber .50 gun—known officially as the "Browning machine gun, caliber .50, M2, aircraft, basic"—weighs 62½ pounds and is 57 inches long. The gun can take ball, armor-piercing, tracer, or incendiary ammunition in the .50 caliber size. Depending on the ammunition, the MUZZLE VELOCITY is from 2,400 to 2,660 feet per second, and the maximum RANGE is in the neighborhood of 7,200 yards. RATE OF FIRE is 400 to 500 rounds per minute, but like all air cooled automatic weapons, the gun is fired in short bursts.

Both the .50 and .30 caliber are air cooled. A supporting JACKET around the barrel is perforated to admit cooling air.

The .30 caliber gun weighs only 20 pounds and is about 40 inches long. The same types of ammunition are available as for the .50, with muzzle velocities ranging from 2,600 to 2,740 feet per second and with maximum ranges up to 5,500 feet. The rate of fire of the .30 caliber aircraft gun is very high, 1,350 rounds per minute. The gun is fired in short bursts, and the high rate of fire enables a flyer to throw a lot of bullets during the fraction of a second he is on target.

ABOUT THEIR OPERATION

The method of operation of the two guns is the same, and a description of the caliber .50 will serve, in the main, for both guns.

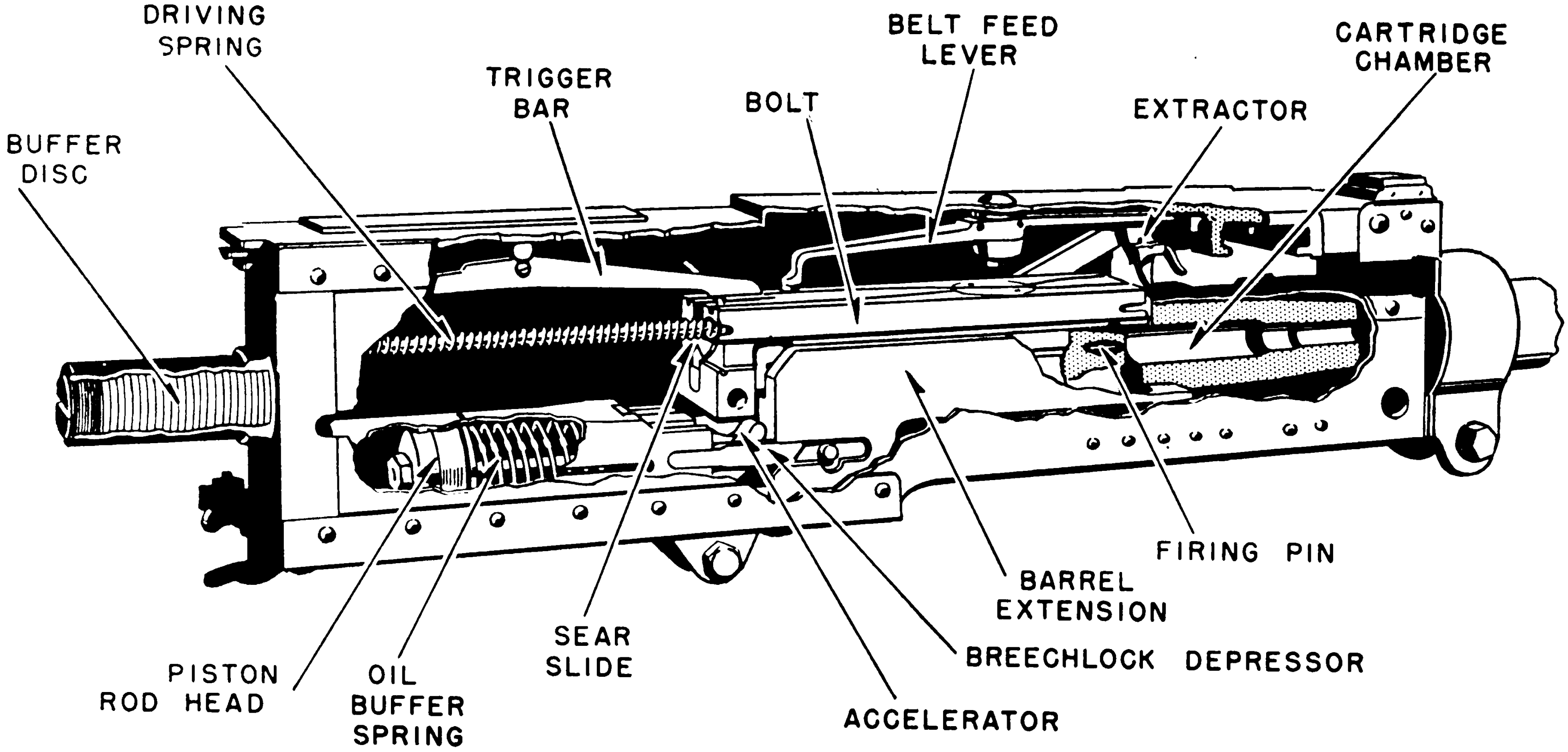


Figure 17.—Cutaway view of .50 caliber BAM gun.

The RECEIVER is the box-like outer portion of the gun visible in figure 17. As in the other weapons studied, this is the chassis or frame of the gun which is fastened to the airplane or mount. Since the BAM is recoil-operated, it is obviously impossible to fasten the barrel directly to the receiver. Instead, the barrel is fastened to a piece known as the BARREL EXTENSION which extends backward into the receiver. It has a flat bottom and can slide back and forth on the floor of the receiver.

The BOLT closes the breech and operates the gun. In the battery position, the bolt rests on the upper surface of the barrel extension. When the breech opens, the bolt slides back along the barrel extension and on to a track provided on the top of the oil buffer body. The DRIVING SPRING behind the bolt is always trying to hold it forward.

When the breech is closed, the bolt is locked to the barrel extension by a piece known as the BREECH LOCK. This is a metal plate which rides in a vertical slot in the barrel extension. When the gun is in battery, the breech lock is lifted by a ramp, or CAM, fastened to the floor of the receiver. In its lifted position, the lock fits into a notch in the underside of the breech bolt, locking it into the closed-breech position.

"COMMENCE FIRING"

Assume that the gun is in battery, a cartridge in the chamber, the breech closed and locked.

Running through the center of the breech block is a spring-loaded FIRING PIN held cocked by the SEAR. The sear is a vertical plate mounted on the after end of the breech block in such a way that it can slide up and down. A hook at its bottom mates with a hook at the end of the firing pin and holds the pin cocked.

The sear can be moved downward in two ways.

One way is used on flexible guns—guns mounted on swiveling supports to be fired by an individual gunner. Such guns are operated by means of a TRIGGER at the rear. When the trigger is pressed down it pushes up the after end of the TRIGGER BAR. (See fig. 18.) The trigger bar pivots, and its forward end moves down, pushing the sear down. When the sear goes down, it releases the cocked firing pin, which springs forward and hits the cartridge.

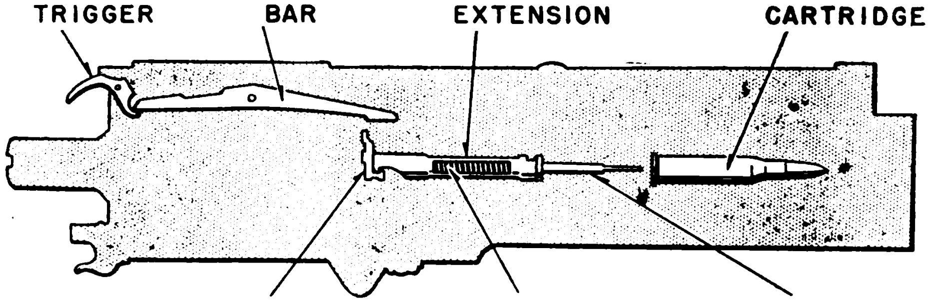


Figure 18.—Firing mechanism of the BAM .50.

FIXED guns—those which are rigidly mounted on the wings or fuselage and aimed by aiming the plane—are fired from the side by remote control. A solenoid on the side of the receiver is operated by a firing button in the pilot's compartment. When current passes through the solenoid, a shaft is pushed in through the side of the receiver. Mounted at the back of the breech block is a horizontal sliding piece with a slanting cam surface which engages a similar surface on the sear. When this SEAR SLIDE is pushed sideways, the sear is cammed down, firing the piece.

THE RECOIL STROKE

When a gun fires, the expanding gases in the chamber exert a rearward pressure on the breech bolt. Since the bolt is locked to the barrel exten-

sion, the barrel, barrel extension, and bolt all are driven backward together.

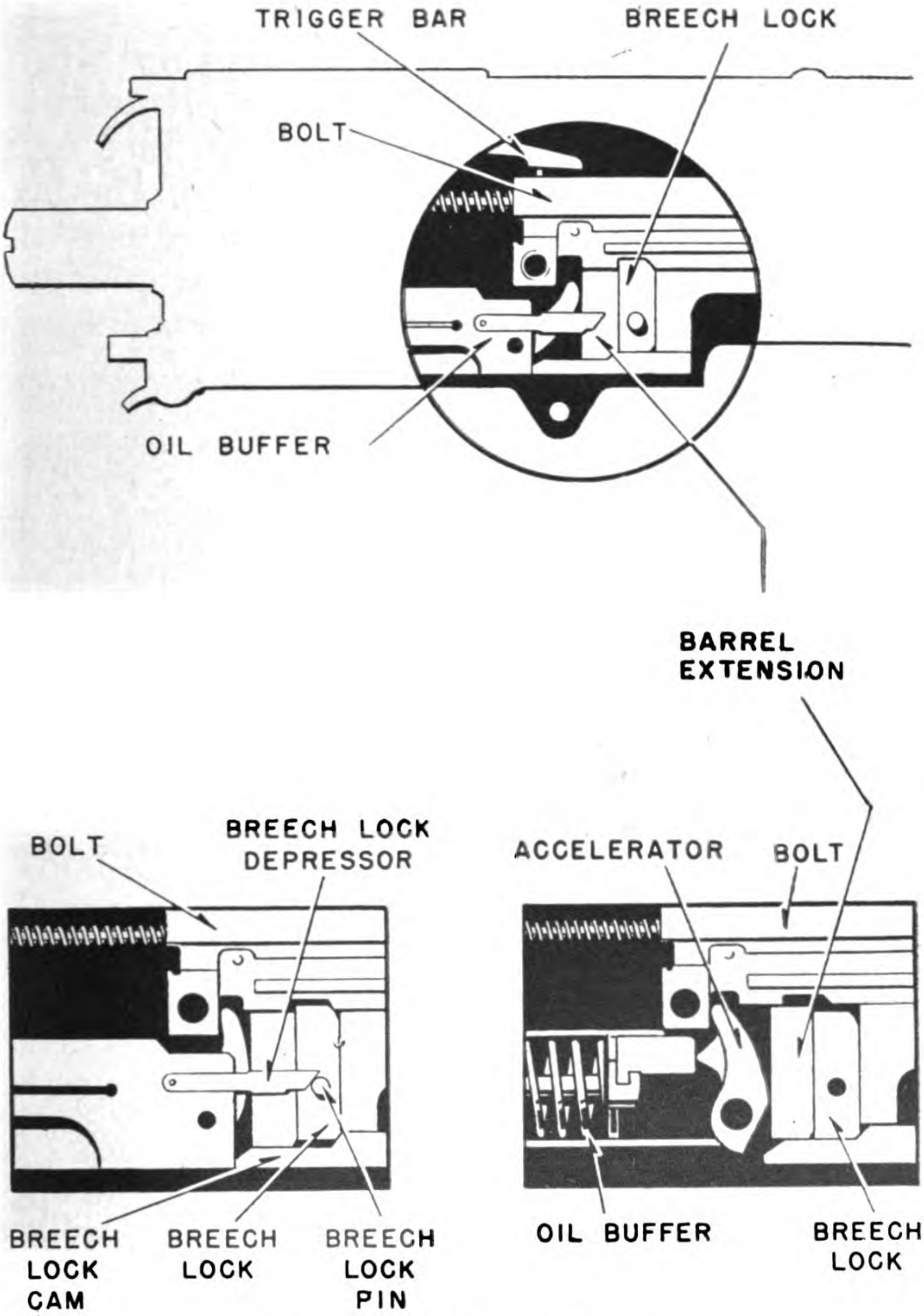


Figure 19.—Unlocking the breech.

When the recoiling pieces have moved back about .75 inch, the breech lock moves off the cam

ramp on the floor of the receiver and is pushed downward by the LOCK DEPRESSORS, arms extending forward from the oil buffer. This UNLOCKS the bolt from the barrel extension. You can see this action in figure 19.

At this moment, the barrel extension hits the ACCELERATOR. This is a curved lever pivoted to the oil buffer at its lower end. The rear face of the barrel extension hits the curved side of the accelerator, a little above the pivot, and causes it to swing. The upper end of the accelerator engages a slot in the underside of the bolt. As the accelerator swings, the bolt is flipped rapidly to the rear. By this action, the recoil movement of the barrel and barrel extension is slowed while the backward movement of the bolt is accelerated.

The movement of the barrel and barrel extension is halted when the extension hits the OIL BUFFER assembly. This is a unit consisting of a spring and an oil cylinder which work together to cushion the shock. When the buffer spring is fully compressed, a pair of hooks on the accelerator grab the projecting SHANK at the rear of the barrel extension. The extension and barrel are thus locked in the recoiled position.

Meanwhile, the bolt continues backward, compresses the driving spring, and finally comes to rest against the BUFFER PLATE. Here the blow is cushioned by a pile of fiber disks.

During the backward movement of the bolt, the firing pin has been cocked, and a cartridge has been stripped from the FEED BELT and dropped into the action in front of the bolt. You will see how all this is done in a few minutes.

Now the driving spring pushes the bolt forward. As the bolt goes forward, it advances the feed belt one round. The bolt hits against the top of the accelerator and unlocks the oil buffer spring. This starts pushing the barrel extension forward. The

rapidly moving bolt overtakes the barrel and barrel extension, rams the fresh cartridge into the chamber, and closes the breech. At this same moment, the barrel extension has moved far enough forward so that the breech lock starts to ride up the cam surface on the receiver, engaging the notch on the underside of the bolt and locking the bolt to the barrel extension.

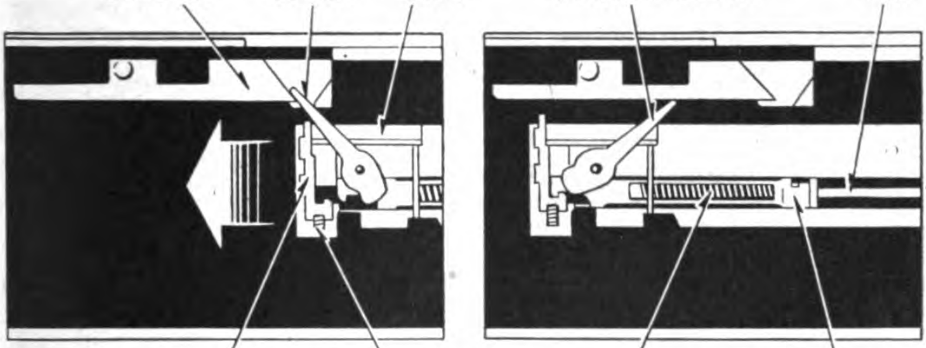


Figure 20.—How the firing pin is cocked.

Pushed by the driving spring and the buffer spring, the bolt, barrel, and extension, all locked together, move forward into the battery position.

If the gunner has been holding the trigger down all this time, the sear hits against the trigger bar as the gun comes to battery, is cammed downward, and the gun fires again, repeating the whole process.

The BAM firing pin is cocked by a small COCKING LEVER which sticks up out of the top of the bolt. During the backward or recoil stroke of the bolt, this lever slips into a notch in the TOP PLATE BRACKET attached to the top of the receiver and is flipped over, cocking the firing pin. See figure 20.

HOW THE AMMUNITION FEEDS

Since the BAM is belt fed, it requires a more elaborate feeding system than the automatic guns

you have already studied. There are four steps which the gun must carry out.

It must move the belt forward.

It must withdraw a cartridge from the belt.

It must ram the cartridge into the chamber.

And it must extract the fired cartridge.

To pull the belt, a slanting TRACK is cut into the top face of the bolt (fig. 21). Fastened to the underside of the receiver cover is a long lever,

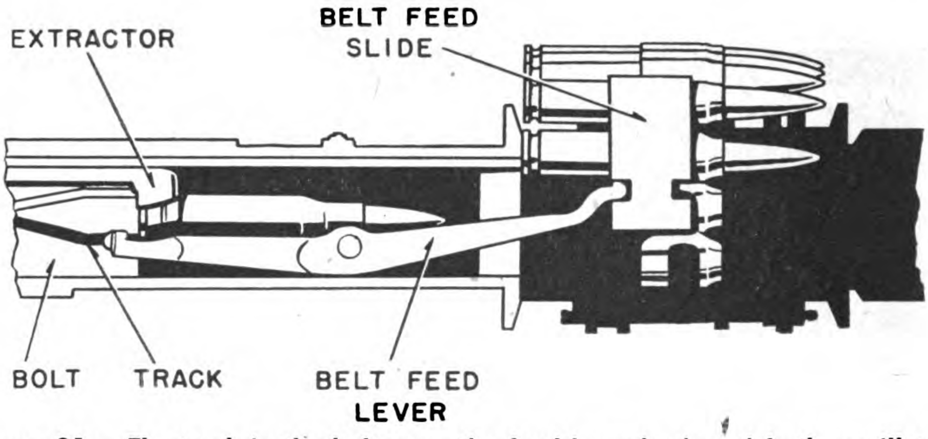


Figure 21.—The track in the bolt cams the feed lever back and forth, oscillating the belt feed slide.

pivoted so that it can move from side to side. A lug at the after end of this lever rides in the slanting groove or track on the bolt (actually there are two tracks on the bolt slanting in opposite directions, so that the gun can be set up to feed either from the right or from the left). As the bolt moves back and forth it causes the BELT FEED LEVER to rock from side to side. The forward end of the lever fits into a notch on the BELT FEED SLIDE. This is a block of metal mounted above the belt so that it can slide from side to side in a track fastened to the receiver. A spring loaded pawl, the BELT FEED PAWL, is pivoted to the slide (fig. 22). Another pawl, the BELT HOLDING PAWL, is fastened to the receiver.

Now suppose the gun is feeding from the left. As the slide moves to the left, the stop pawl pre-

vents the belt from moving with it. (Position *B*). So the belt feed pawl rides over a cartridge and snaps down behind it. Then, as the slide moves to the right, the feed pawl pushes the cartridge

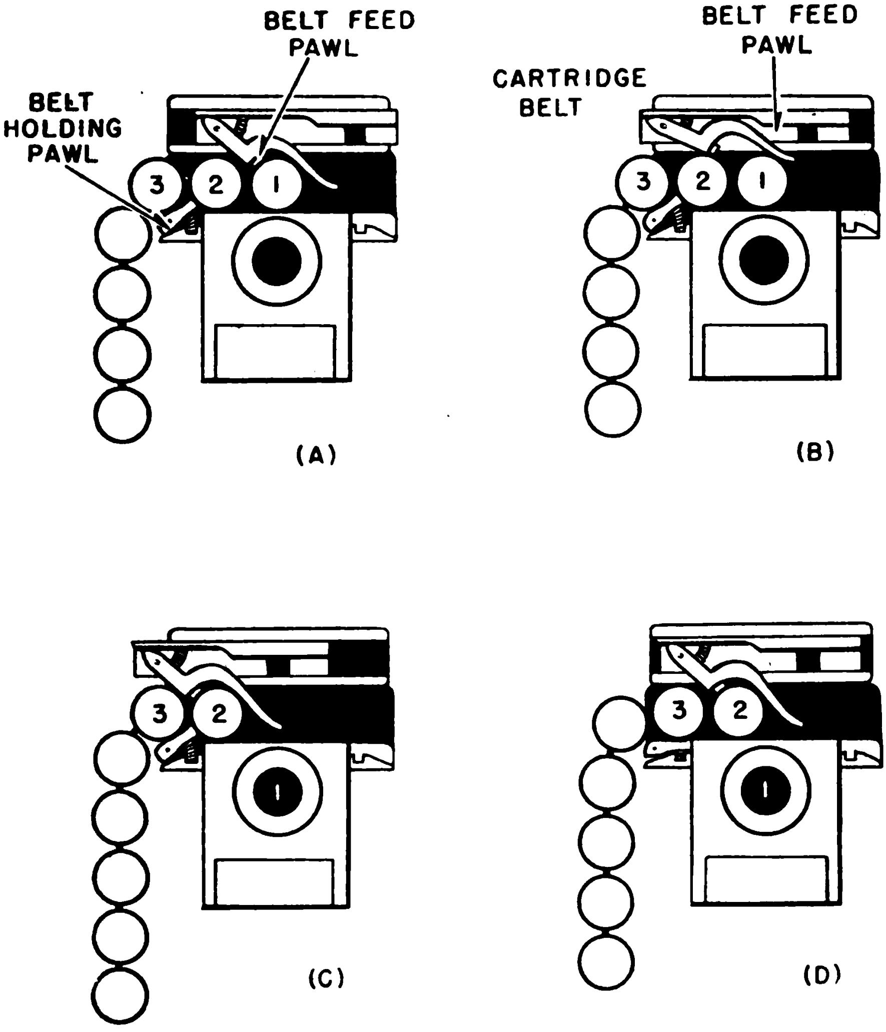


Figure 22.—How the pawls drive the belt forward as the slide moves back and forth.

ahead of it, dragging the ammunition belt forward one cartridge. (Position *D*). The movement of the belt is halted, each time, when the cartridge strikes the front and rear CARTRIDGE STOPS. These are metal blocks which stop the cartridge at the proper position. Thus, each time the gun fires, the belt is advanced one round.

Fresh cartridges are taken out of the belt and fed into the action of the gun by a piece called the EXTRACTOR. This is a claw mounted on an arm pivoted to one side of the belt. A lug on the outside of the extractor rides in a cam track on the side of the receiver. This track guides the upward and downward pivoting of the extractor.

Near the end of the forward or counter-recoil stroke of the bolt the cam surface on the receiver forces the extractor to pivot upward so that the claw grips the head of the next cartridge in the belt. When the gun fires, the bolt moves backward dragging the fresh cartridge out of the belt. The belt link is held forward by a fork-shaped LINK stripper. As the extractor is cammed downward, it forces the head of the cartridge down into a T-SLOT on the face of the bolt. Then as the bolt comes forward again in counter recoil, the cartridge is rammed into the chamber.

The head of the cartridge remains gripped in the T-slot. When the bolt moves backward the next time, it pulls the spent cartridge with it, extracting it from the chamber. Meanwhile, the extractor is pushing a new cartridge in at the top of the T-slot. The spent cartridge is forced downward to the bottom of the bolt and falls out the bottom of the gun.

The automatic action of a gun can only start when a live cartridge is in the chamber. Therefore, when you first load up the BAM you have to get a cartridge into the chamber—or CHARGE the gun—by hand. For this purpose, a stud is fastened to the side of the bolt and extends out through a slot in the receiver. Then some means is provided for pulling the bolt back and thus running the gun through its operating cycle by hand. On flexible guns a CHARGING HANDLE is connected to the stud. For fixed guns, which are operated by remote control, a hydraulic charging mechan-

ism is installed and is controlled by a valve in the pilot's cockpit.

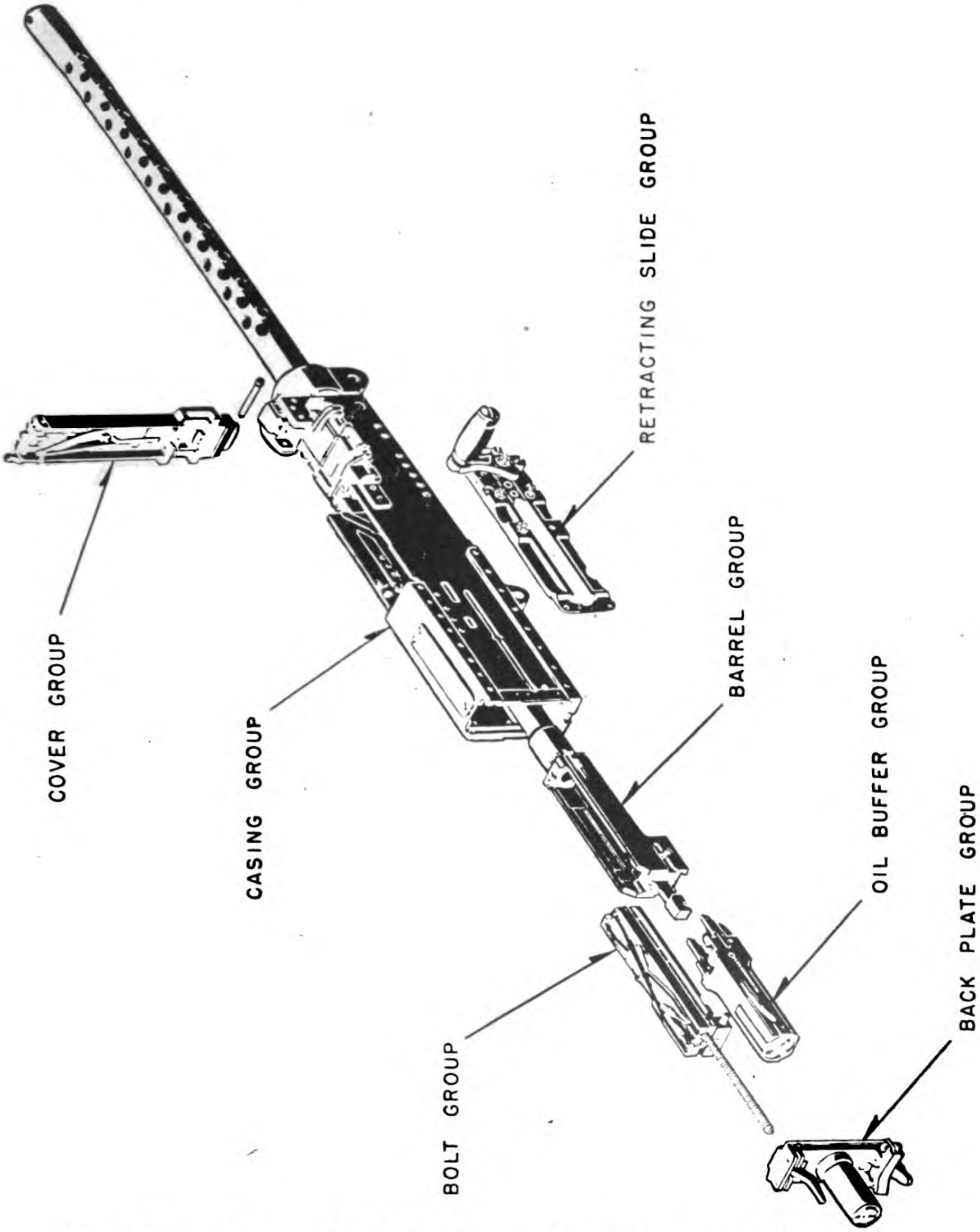


Figure 23.—Disassembly of the .50 caliber BAM gun according to groups.

THE RECEIVER GROUP

For convenience in assembly and disassembly, the parts of the gun are divided into groups which can be removed or installed as a unit (fig. 23).

On the following pages you will find pictures of the parts of a BAM gun broken down into groups.

The RECEIVER GROUP (fig. 24) makes up the main frame or chassis of the gun and contains most of the non-moving parts. The moving parts of the gun work inside the receiver. The mounting holes by which the gun is fastened to the airplane

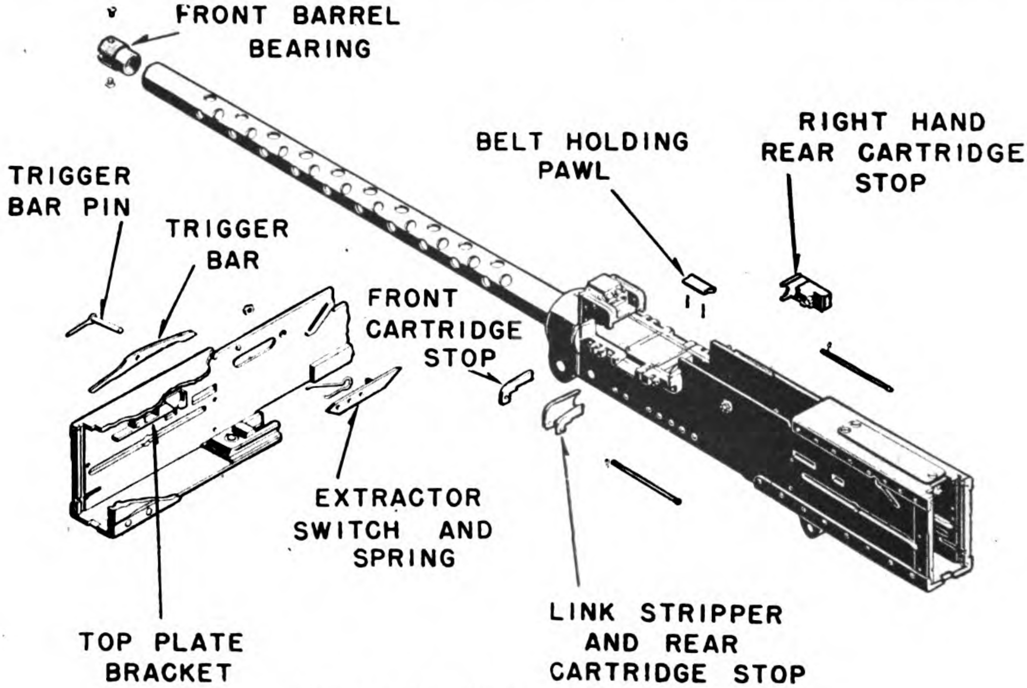


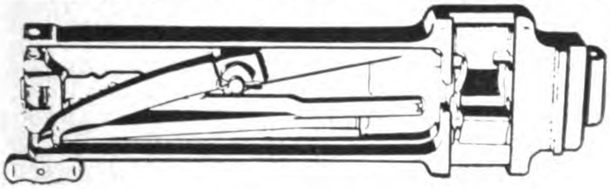
Figure 24.—The receiver group.

are in the receiver. There are two sets of these holes—a pair aft on projecting lugs and a pair in a TRUNNION ADAPTER which is fastened to the forward edge of the receiver around the barrel.

The receiver itself is made of two steel side-plates, riveted at the forward end to a TRUNNION BLOCK. Top and bottom plates are riveted to the after end of the side plates. The front portion of the receiver is open at the bottom to permit ejection of empty cartridge cases, while the top of the receiver, at the front, is closed by a hinged COVER which is considered as a separate group.

Besides serving as the frame of the gun, the receiver carries the trigger bar.

A bracket fastened to the top plate has a cam slot to engage the cocking lever of the bolt.



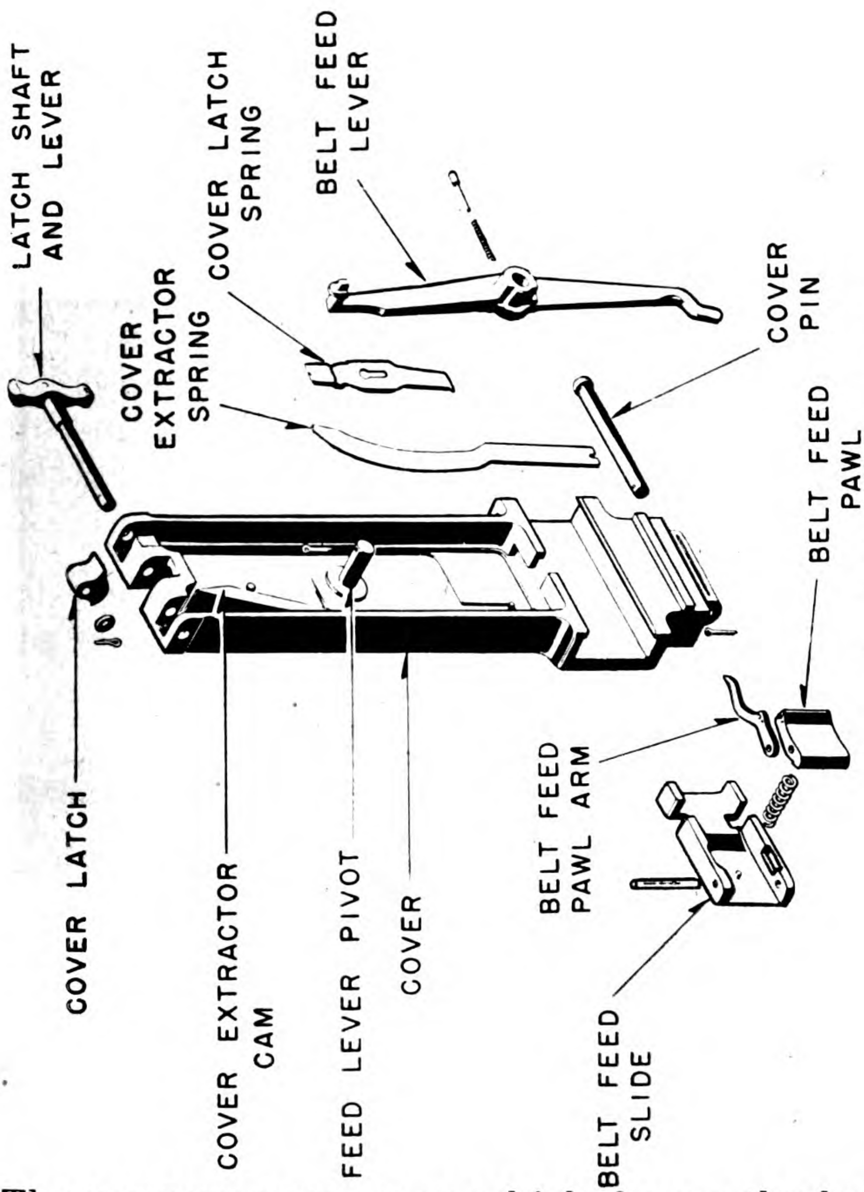


Figure 25.—The cover group.

The BREECH-LOCK CAM which forces the breech lock up into the locked position when the gun is in battery is fastened to the bottom plate of the receiver.

Part of the camming surfaces which control the movement of the extractor are attached to the side plate of the receiver.

The BARREL JACKET which admits cooling air around the barrel and supports it is screwed to the front of the receiver, and the rear of the receiver is slotted to receive the BACK PLATE GROUP, which will be discussed later.

THE COVER GROUP

The COVER or BELT FEED GROUP (fig. 25) is hinged to the top of the receiver. It serves as a cover for the receiver and can be lifted up to provide access to the interior of the gun. It also contains the belt feed mechanism. The BELT FEED LEVER is pivoted to the cover, and the BELT FEED SLIDE moves in tracks on it, carrying the belt feed pawl. Also attached to the cover are some of the cams controlling the movement of the extractor.

THE OIL BUFFER GROUP

Principal part of the OIL BUFFER GROUP is the buffer assembly which cushions the impact of the

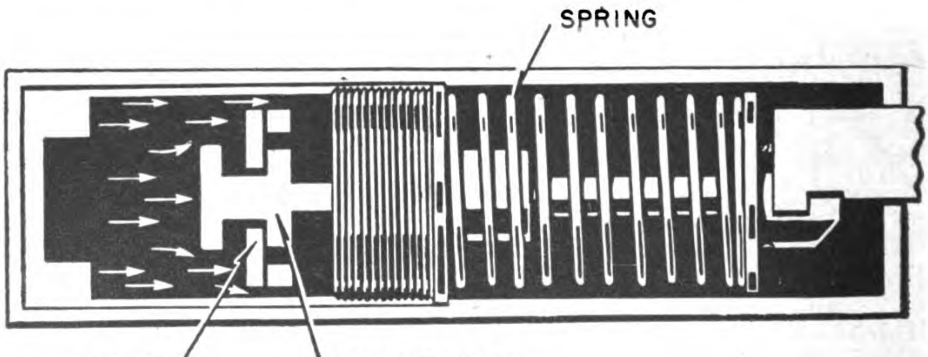


Figure 26.—How the oil buffer works.

recoiling barrel and barrel extension. This consists of a spring and an oil cylinder. In figure 26 you can see how this works. Before the barrel extension strikes, the spring is extended and the

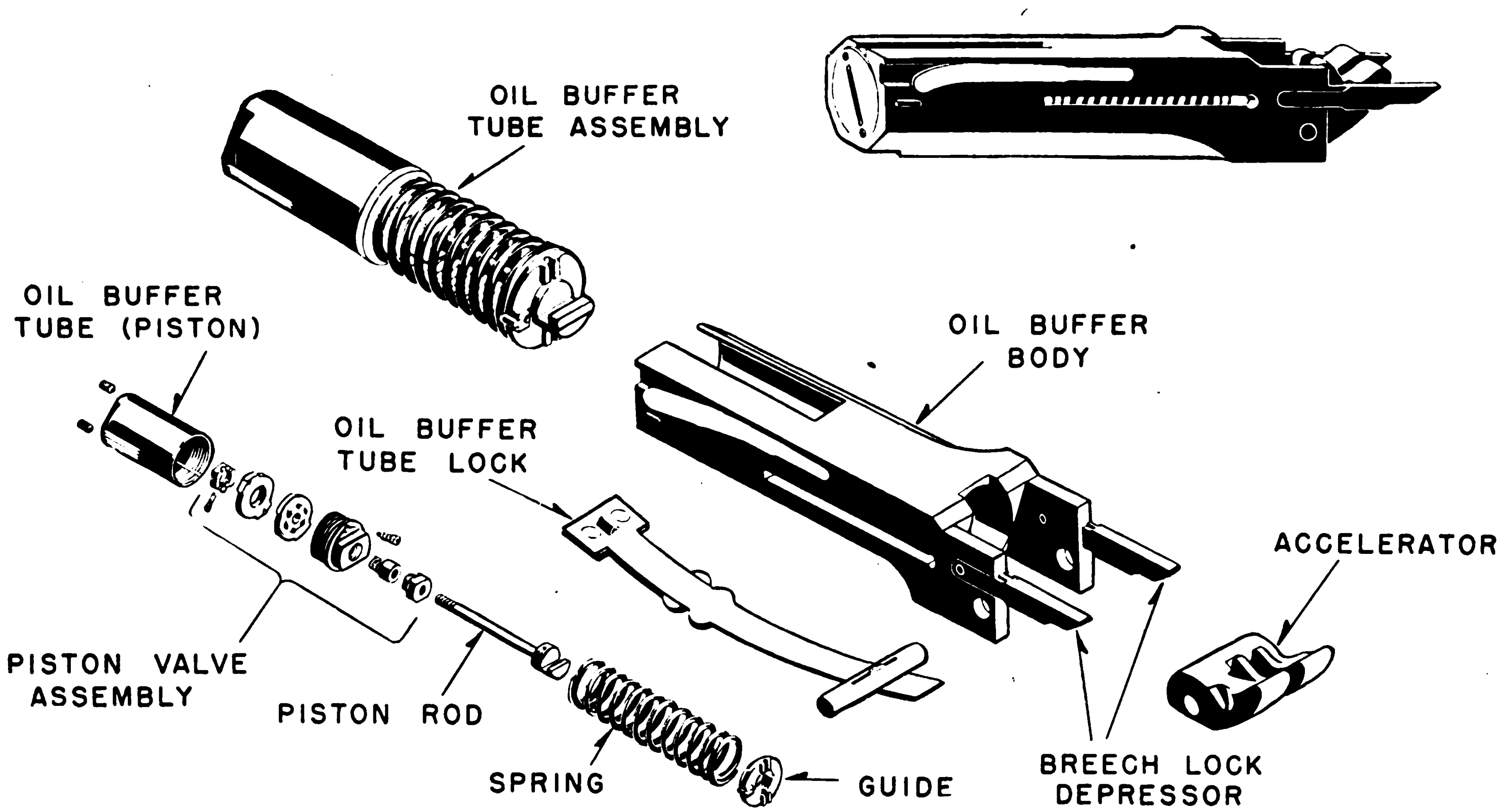


Figure 27.—Oil buffer group.

piston is in the forward part of the cyinder with the piston valve resting against it. When the barrel extension strikes, the spring is compressed. At the same time the piston is driven to the rear.

In order for the piston to move, the oil which is behind it must get in front of it. The only route is through the small holes in the piston valve. As the oil is slowly forced through these holes, the movement of the barrel extension is smoothly slowed down and stopped.

On the counter recoil stroke, the spring pushes the barrel extension back into battery, dragging the piston with it as it does so. On this stroke, however, the piston valve slips back to the far end of the piston stem, and the oil is able to flow freely through six good-sized holes in the piston. Thus no resistance is imposed to counter-recoil.

The oil buffer body has the ACCELERATOR pivoted to it. The function of the accelerator, you remember, is to flip the bolt backward during the recoil stroke and also to lock around the barrel extension shank and thus lock the barrel and extension into the recoil position. Sticking out in front of the barrel buffer body are two shafts known as the BREECH LOCK DEPRESSORS. These have cam surfaces which engage lugs on the sides of the BREECH LOCK. They force the lock downward during recoil when it rides off the BREECH LOCK CAM. These depressors provide a positive unlocking action during the recoil stroke.

THE BARREL GROUP

The BARREL AND BARREL EXTENSION are screwed together securely and are considered as one group (fig. 28). The only moving part within this group is the breech lock, which slides up and down in a slot in the barrel extension. And the bolt rides in grooves machined in the barrel extension.

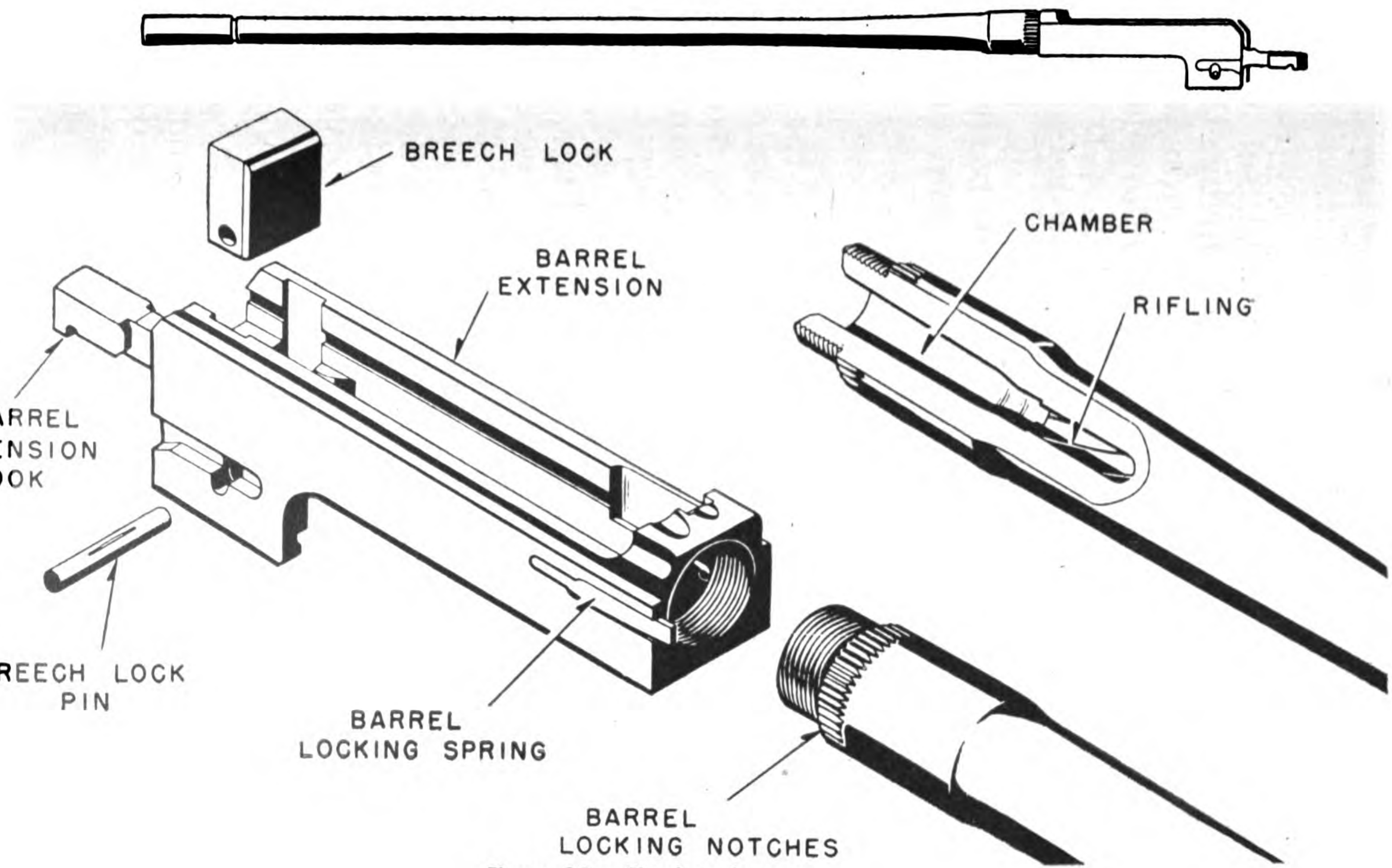


Figure 28.—The barrel group.

THE BACK PLATE GROUP

Two types of BACK PLATE GROUP are used. Both of them slide on to the after end of the receiver and close up the end. Both of them contain the buffer assembly with its disks. On guns set up for fixed mounting with remote control firing, that is all there is to the back plate. Flexible guns, which are aimed and fired by gunners standing behind them, sometimes contain hand grips and a trigger. The caliber .30 gun in figure 16 has a back plate of the flexible type while the caliber .50 is set up as a fixed gun. Figure 29 shows the basic back plate which can be used in a fixed mount or gun adaptor.

THE BOLT GROUP

The BOLT itself (fig. 30) does most of the work of operating the gun. It closes the breech. The firing pin and sear are mounted in the bolt, as well as the cocking lever which cocks the firing pin. The extractor, which draws the cartridges from the belt, is pivoted to its side. A T-slot on its forward face carries fresh cartridges into the action and extracts the spent cartridge from the chamber. The camming tracks on the top of the bolt operate the belt feed mechanism.

The driving spring fits into a recess in the after end of the bolt. It is compressed when the bolt moves backward and then, expanding, drives the bolt forward on counter-recoil.

The description given so far of the BAM will apply to both the caliber .30 and caliber .50 gun—with one exception. The caliber .30 does not have the oil buffer. Since the recoiling parts are lighter, it relies entirely on the spring to cushion the shock. In the caliber .30, therefore the buffer group is not known as the oil buffer group as it is in the caliber .50, but instead is called the LOCK FRAME GROUP.

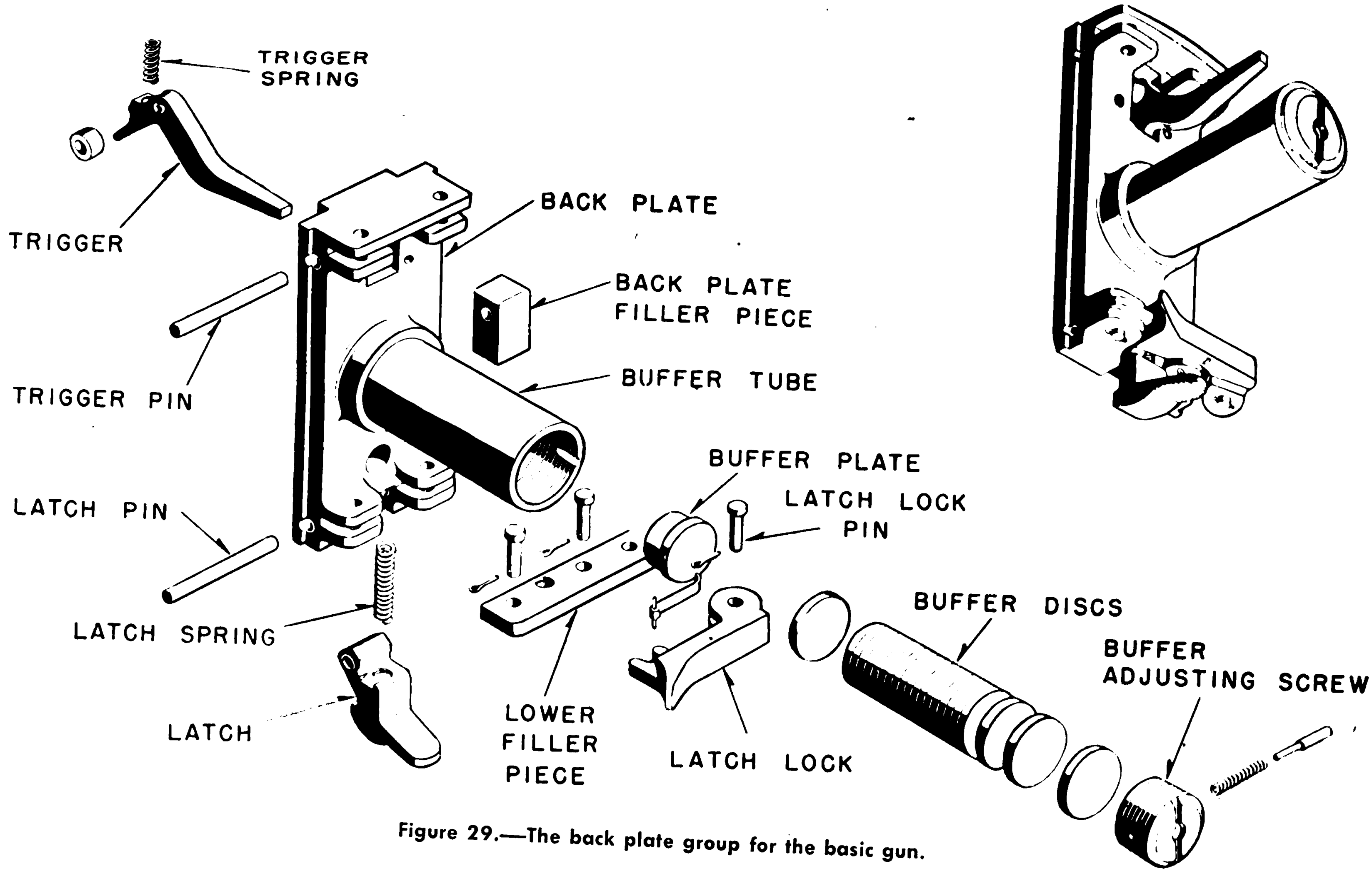


Figure 29.—The back plate group for the basic gun.

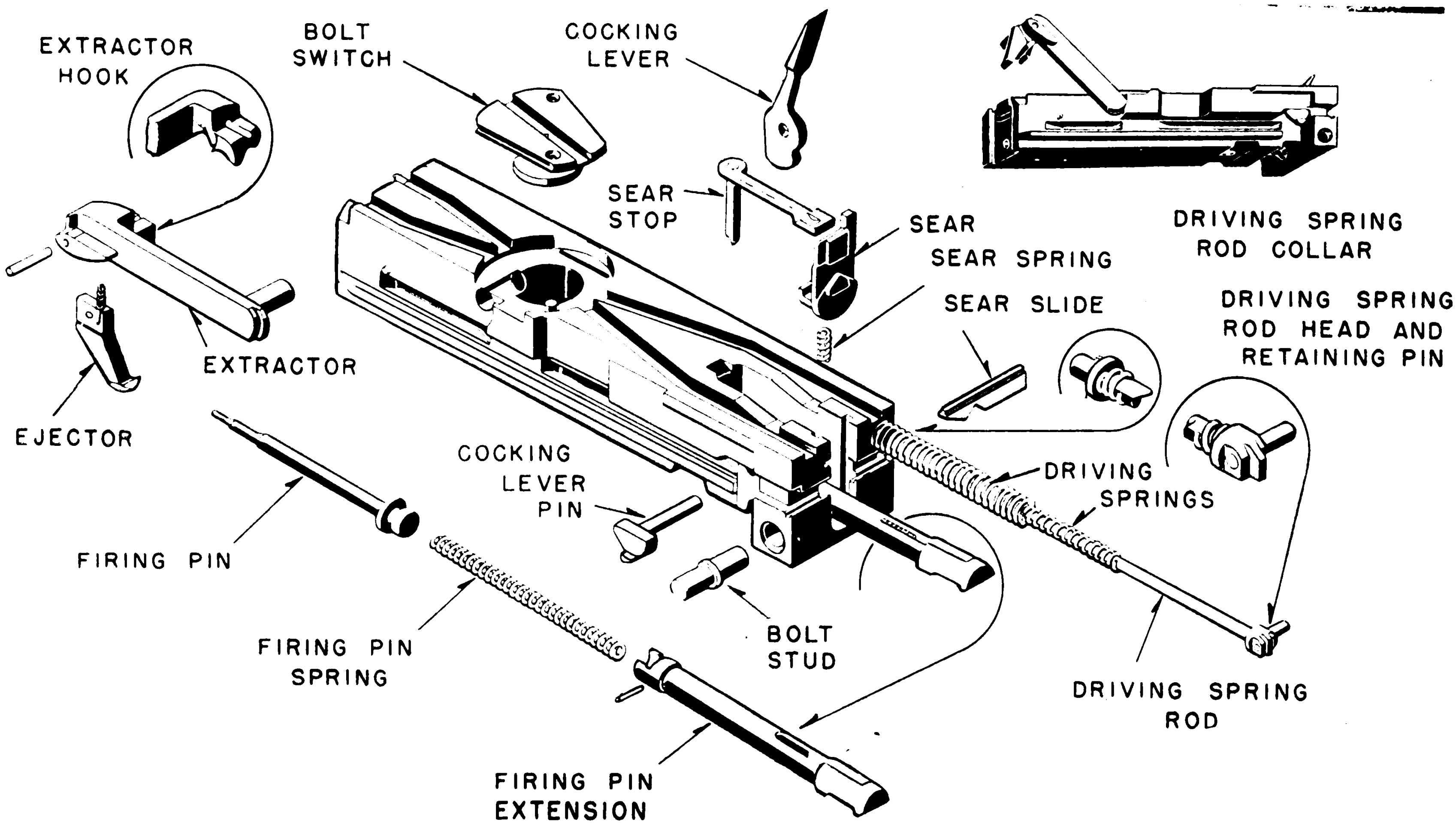


Figure 30.—The bolt group.

KEEP THEM FIRING

As an Aviation Ordnanceman, one of your major jobs will be to clean, lubricate, and repair aircraft machine guns and other small arms. In the case of aircraft guns—even more than with other ordnance—this is a vital job. These guns are subjected to extremes of heat and cold so that dirt or faulty lubrication can easily cause them to fail. And a failure is SERIOUS. The fixed guns, particularly, are out where no one can get at them. If they jam in flight, they are out of action until the plane lands—and that may mean a shot-down plane and a dead crew.

Aircraft guns have to be CLEANED thoroughly when they first come from storage encased in protective greases. They must be cleaned EVERY TIME they are fired. And if the guns are held in a ready condition without being fired, they should be cleaned DAILY.

The routine daily cleaning and cleaning after firing requires that all movable parts be disassembled and thoroughly wiped with dry-cleaning solvent. The bore should be cleaned by swabbing with rifle bore cleaner. Always repeat the swabbing until a clean flannel patch picks up no foreign matter.

When handling gun parts which have been cleaned but not yet lubricated, always WEAR CLOTH GLOVES. Perspiration from your hands will corrode metal which is not protected by oil.

A special cleaning job is required when guns are first received from STORAGE. When machine guns are stored or shipped they are ordinarily covered with a heavy grease to protect them from rust. Usually, the entire gun is dipped into a molten grease which seeps into every crack and opening, covering all working parts. When the gun is removed from the solution, the grease cools and sticks to the gun, forming a uniform airtight

coating. Obviously, a gun cannot operate in such a condition, and it's a real job to get the gun back into working shape.

Every bit of grease must be removed. The best method is to subject the entire gun, EXCEPT FOR THE OIL BUFFER ASSEMBLY, to a pressure-steam bath or to trichlorethyne vapor. The gun must be disassembled as far as possible without damaging the parts.

The OIL BUFFER of the .50 caliber gun cannot be de-greased at high temperature because it contains a packing gland soaked in beeswax which will become defective if heated. If vapor cleaning is not possible, the gun can be completely disassembled and cleaned by hand. Remove all traces of grease by use of dry-cleaning solvent or clear gasoline. Pay particular attention to getting the grease off the bolt, especially the part including the firing pin, its spring, and its recess in the bolt. The grease can be removed from the bore with a cleaning rod and brush and a little solvent.

A new method of shipping guns which avoids this nasty de-greasing job is now being introduced. In this method, the entire gun is enclosed in a transparent waterproof envelope which also contains a pellet of moisture-absorbing material. Guns shipped in this manner carry no preservative grease. They have been oiled and adjusted for firing and are ready to use.

Guns which are to be stored unused for months should be cleaned thoroughly on three successive days and then coated with light rust preventive compound.

LUBRICATION of the machine gun in a matter of getting a thin film of oil onto all the parts. Procedure is to disassemble the gun completely, and wipe all parts with an oily cloth saturated in special preservative lubricating oil. The oil now used is Ordnance Specification 1361.

If the guns are to be used at temperatures lower than 30° below zero—as will frequently be the case in high altitude work—a different procedure should be followed. Saturate a clean lintless cloth in oil and then wring it dry. Wipe over all the parts with this cloth. Then take a dry clean lintless cloth and thoroughly remove as much of the oil as you can with the cloth. This will leave a very thin coat of oil on all the parts.

If too much oil is left on the gun at low temperatures, the oil will become gummy and will interfere with proper operation.

The OIL BUFFER of the .50 caliber should be filled with light recoil oil. (U. S. Army Specification 2-360). In emergencies, the regular lubricating oil can be used, but this will not work satisfactorily at temperatures lower than 30° below zero.

REPAIR of the Browning machine gun is largely a matter of replacing worn or broken parts. In addition, a certain amount of polishing and stoning of working surfaces is necessary during the entire life of the gun in order to relieve friction and to remove burrs set up by firing. Burrs on screw heads, threads, and the like should be removed with a fine FILE. But on working surfaces such as the CAM GROOVES on top of the bolt, the engaging surfaces of the SEAR SLIDE, the SEAR, and FIRING PIN EXTENSION and such parts as the ACCELERATOR and BREECH BLOCK, burrs should be removed with a fine-grain sharpening STONE. Rounded contacting surfaces can be smoothed and polished with CROCUS CLOTH.

To do work of this character, you need an intimate familiarity with the guns—a far more intimate familiarity than you can gain by reading any book. To become a good Aviation Ordnanceman you must work with the guns—and work with them under the supervision of men who really know them.

Seize every opportunity to service the guns. Don't hesitate to ask questions. And think while you work. Whenever you handle a part, visualize the job that part has to do in the firing of the weapon.

ADJUSTMENTS OF THE BAM GUN

In many ways an aircraft machine gun resembles the motor of an automobile. Actually it is a one-cylinder internal combustion engine—burning smokeless powder for fuel instead of gasoline. And like an automobile engine, the BAM must be TUNED UP for best performance. If it isn't tuned up, it may fire too slowly, it may fail to feed long heavy ammunition belts, and almost always the accuracy will suffer.

To do a real job of tuning a machine gun, you need the intimate familiarity with it that can come only from working with guns. But there are two important adjustments that every ordnanceman should be familiar with right from the start—adjustment of the headspace and the timing of the gun.

HEADSPACE is the distance between the after end of the barrel chamber and the forward face of the bolt—when the breech is closed and locked. You can readily see that there must be a small clearance at this spot to permit the gun to operate. Suppose the barrel extended too far back into the gun, the bolt would come forward as far as it could until the front face of the bolt struck the end of the barrel. But the bolt would not have moved far enough forward to bring the slot on its underside above the breech lock mounted in the barrel extension. The breech lock would be unable to rise. When the barrel and barrel extension, carrying the bolt, tried to move forward into the battery position, the breech lock would hit the breech lock cam on the receiver bottom plate. Ordinarily the

lock rides up the cam, fitting into the slot on the breech bolt, and the barrel extension continues to move forward into battery. In this case, however, the lock cannot rise—it cannot ride over the cam—and the mechanism jams. The barrel extension can't get forward into battery.

The gun will not fire, because the bolt is not far enough forward to bring the sear in contact with the trigger bar.

Even if the gun did fire, it would not feed, because the extractor has not been brought up to where it can grab a fresh cartridge from the feed belt.

There must be sufficient clearance in the headspace to permit the bolt to come forward and lock.

Then why not provide a good loose fit and be sure that the bolt can always get forward?

That won't work because too loose a fit will cause almost as much trouble as too tight a fit. If the fit is loose, you can't be sure that the cartridge will be rammed all the way home in the chamber. Sometimes it will seat all the way, sometimes it won't. This destroys the accuracy of the gun, because the bullet behaves differently when it is fully seated and when it isn't.

If the cartridge does seat all the way in the chamber, in spite of the loose headspace, a small space will be left between the back of the cartridge and the face of the bolt. If this space is too great, the firing pin may not be able to reach the cartridge, and the gun will not fire. If the gun does fire, the gas pressure against the unsupported base of the cartridge may blow it out, rupturing the cartridge. Then the ruptured cartridge cannot be extracted, and the gun will jam when it tries to ram home a fresh cartridge.

You can see that letting the headspace get too small or too large will ruin the performance of the gun.

HOW TO ADJUST HEADSPACE

Headspace is adjusted by screwing the barrel in and out of the barrel extension. A ring of notches is machined on the outside of the barrel, and a spring clip on the barrel extension snaps into one of the notches when you have adjusted the headspace. This spring clip locks the barrel and prevents it from creeping in and out of adjustment.

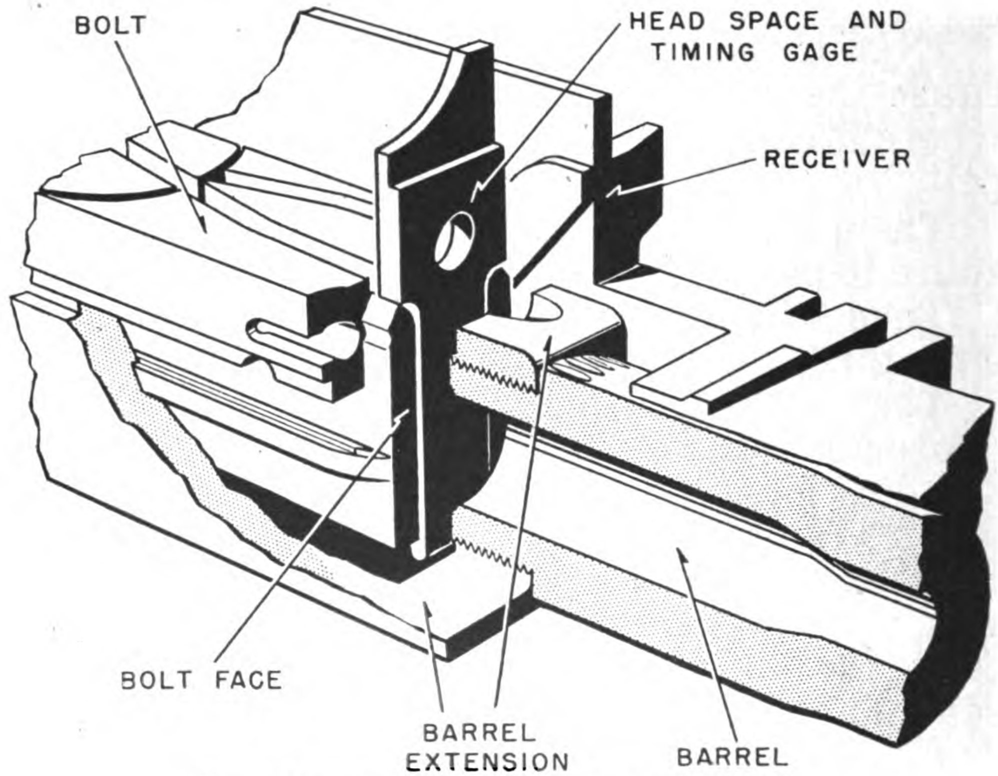


Figure 31.—Checking headspace with the gage.

Special gages are provided for head spacing. One comes with a timing gage attached to it. It is a combination headspace and timing gage. The end of the gage used for headspace is so marked. The other uses both ends for head spacing.

To check headspace, close the breech and try to slide the GO end of the gage down into the T-slot in the face of the bolt (fig. 31.). Be sure to pull back the bolt slightly—using the charging HANDLE or extractor to relieve the pressure of the driving spring. If the gage will not go in, the headspace

is too tight, and the barrel must be screwed out of the barrel extension. Now try the NO-GO end. If it WILL go in, the headspace is too loose.

The combination gage is a GO gage only. If it fits sloppily, the headspace is too loose. Screw the barrel into the extension until the gage will just slide in.

Fundamentally, the adjustment of headspace on the caliber .30 and caliber .50 gun is the same job. However, you have to use a slightly different method. On the caliber .50, the entire operation can be performed with the gun assembled. On the caliber .30, however, the spring lock is designed so that you have to disassemble the gun to screw the barrel in and out of the barrel extension. In this case, you assemble the breech bolt to the barrel extension in the closed breech position. Lock the bolt by pushing the breech block up with your fingers. Screw the barrel into the extension as far as it will go. Then back off the barrel one notch. Assemble the gun, and check the headspace with the gage.

In an emergency it is possible to adjust the headspace on the BAM without any special tools at all. To do this, screw the barrel into the receiver as far as it will go. You have to raise the cover and pull the bolt with the charging handle in order to change the adjustment of the barrel. Now let the bolt go forward and see whether the gun comes fully into battery.

You can tell whether the gun is fully in battery by lifting the cover. If the gun is in battery, the forward edge of the barrel extension should butt against the trunnion block which forms the front of the receiver.

If the action will not go all the way forward, you know that the headspace is too tight. Screw the barrel out of the receiver just enough to move the spring lock from one notch to the next notch.

Pull the bolt back again, let it go forward, and see whether the action moves into battery. Continue the process until you find the setting at which the action will just move all the way forward.

TIMING THE BAM

Headspace is the most important adjustment on the BAM. Second only in importance, however, is the adjustment of timing.

To understand the timing adjustment, recall what happens during the counter-recoil stroke of the action. The bolt moves forward, closes the breech, and locks. Then the bolt, barrel extension, and barrel move forward together into battery. As the action approaches battery, the sear mounted on the bolt hits against the trigger bar and is cammed downward, releasing the firing pin. On a fixed-mounted gun the sear slide hits against the solenoid shaft, is cammed to one side, and cams the sear downward.

To get the best performance out of a gun, you want the explosion of the fresh cartridge to occur at just the time which will make the action start to recoil the instant it comes into battery. However, it takes a certain amount of time, after the sear has been depressed, for the firing pin to move forward and for the explosion to occur. Therefore, the BAM is designed so that the sear will strike the trigger bar—or the sear slide will strike the solenoid shaft — a short distance before the action gets into battery.

But this distance — the timing adjustment — must not be too great. If the gun fires too soon, the action will start to recoil before the gun has come fully into battery. In extreme cases, the bolt will not get far enough forward for the extractor to grab a fresh cartridge out of the feed belt. And even if it's not that bad, the ability of the gun to

pull a heavy ammunition belt will be cut down because the recoil force will be less.

You use the timing end of the timing-headspace gage to check the timing of the BAM.

This is how you do it—

With the chamber empty, pull the charging handle all the way back and let it go forward again. This is to cock the firing pin. Now pull the bolt back about a quarter of an inch. Since the breech is locked, the barrel and barrel extension will be drawn back with the bolt. With the cover of the gun raised, slip the NO-FIRE end of the TIMING GAGE in front of the TRUNNION BLOCK on the receiver and allow the action to move forward until the front end of the BARREL EXTENSION comes to rest against the gage.

Now pull the trigger. Nothing should happen.

If the firing pin snaps, the timing distance is too great and must be reduced.

Now repeat, using the FIRE end. If the pin does NOT snap, the timing distance is too small.

Timing on the fixed-mounted gun can be adjusted by screwing the solenoid shaft in and out. No adjustment is provided on the flexible mounted gun, which fires by means of a trigger bar. To change the timing on such a gun, remove the trigger bar and measure it against a group of spares. Find a spare which is a little bit longer or shorter than the one you removed from the gun and use that one as a replacement. Now check the timing again.

RULES TO REMEMBER

Here are some SAFETY RULES that you should follow whenever you are working on a machine gun.

Be sure that the gun is securely ANCHORED in its mounting. Never lay a gun down where it may fall.

Be sure that the chamber and the bolt have NO CARTRIDGES in them.

Never COCK the gun against the pressure of a driving spring when the back plate is removed from the gun.

Never leave TWISTED ENDS of locking wires or cotter pins exposed.

Never ALTER or FORCE any part in such a manner as to prevent its being interchangeable with other guns.

Always be sure that the gun has been adjusted for proper HEADSPACE before you finish working on it.

On assembling a gun, be sure that the COCKING LEVER points FORWARD when the bolt is placed in the receiver.

Keep your tools and bench neat and clean.

After you have finished working on the gun and have test-fired it, pull the bolt back TWICE by hand and raise the cover. Check the T-slot in the bolt and the chamber to be sure no cartridges are still in the gun. Then release the FIRING PIN SPRING.

HOW THE GUNS ARE MOUNTED

The guns you read about in the previous chapter were all small arms which were held in the hand

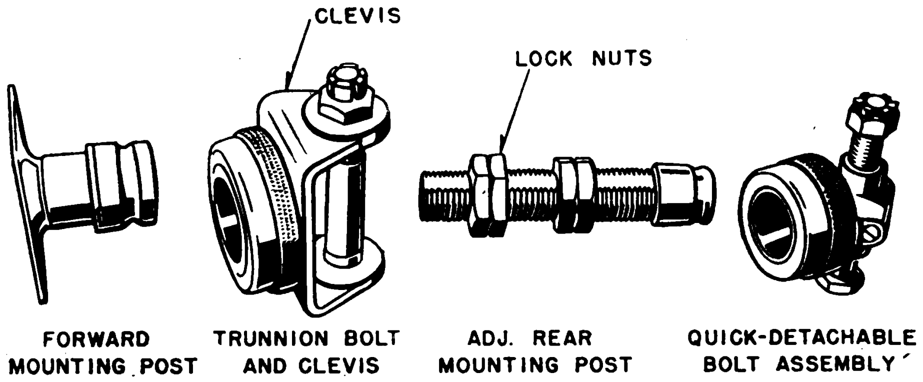


Figure 32.—Equipment for mounting fixed guns.

to be fired or—as in the case of the BAR, provided with a muzzle rest. The caliber .30 and caliber .50 BAM guns, however, are substantial weapons

that have to be mounted firmly in the airplane. Special fittings are provided for this purpose.

There are two kinds of mountings for aircraft guns—FIXED and FLEXIBLE.

The fixed guns are rigidly fastened to the frame of the airplane—usually in the wings, sometimes in the nose or the fuselage. They are carefully lined up with the airplane, and the pilot aims them by aiming the whole plane. The guns of single-seat fighters are always mounted in this way, and most larger planes have a certain number of their guns mounted in the wings.

A two-point suspension is used in a fixed mounting. A special TRUNNION BOLT is slipped through the holes in the TRUNNION ADAPTER at the forward end of the receiver and through matching holes in a special clevis (a U-shaped metal holder) which you see illustrated in figure 32. The clevis is then slipped over a short post built into the airplane. The clevis is locked in place by rotating its knurled collar about 45°. This forces three locking balls inward so that they slip into a groove in the post and lock the clevis in place.

The rear mounting is adjustable. A fitting containing a threaded hole is built into the frame of the plane. The threaded MOUNTING POST is screwed down into the fitting and secured in place by lock nuts. A quick-detachable bolt assembly, similar to the trunnion clevis already described, slips over the post. A threaded sleeve screwed through an upright in the bolt assembly is slipped inside the receiver of the gun at the rear and a trunnion bolt is slid through the two rear holes in the receiver and through the center of the sleeve.

Now the gun can be lined up with the pilot's gunsights by adjusting the rear mounting. The threads on the mounting post are used to raise or lower the gun. To adjust the gun from side to side, the threaded sleeve can be screwed from side

to side in the bolt assembly. This operation is called BORESIGHTING the gun.

MOUNTING FLEXIBLE GUNS

Guns which are swivel-mounted in the fuselage and are aimed by an individual gunner are called FLEXIBLE guns. Such guns are mounted in GUN MOUNT ADAPTERS. These in turn are fastened to a swivel mount built into the airplane. Some adapters are nothing more than simple U-shaped yokes to take a trunnion bolt, but most of them are rather complex frameworks carrying spring or hydraulic shock absorbing gear, handles for the gunner, and feeding mechanisms to guide the ammunition belts to the gun. The gun sights are mounted on the adapter.

A single adapter may hold one, two or even four

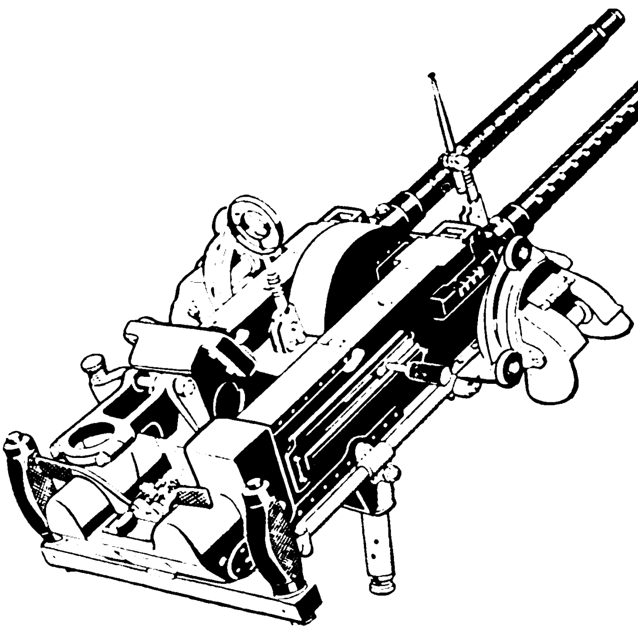


Figure 33.—Gun mount adapter carrying two caliber .30 BAM guns.

guns Figure 33 shows two caliber .30 BAMS mounted in a gun mount adapter. There are many different types of adapter designed to fit different airplanes and different positions in the plane.

As an Aviation Ordnanceman, you are by no means limited to work in the shop. Your job extends to the moment when the air crew takes over. And your basic responsibility is to see that EVERY airplane under your charge takes off with its guns in good firing condition.

Here are a few things you should always do before any airplane whose armament is under your charge leaves the ground.

Wipe the BORE and CHAMBER of the gun barrel.

Be sure that the adjusting screw on the back plate is screwed in tight against the BUFFER disks.

TEST the operation of the gun by hand, using DUMMY CARTRIDGES. Retract the bolt by means of the operating slide on fixed guns or the retracting slide on flexible guns.

Be sure that the SIGHT BASES of flexible guns are clamped securely in place.

Be sure that the AMMUNITION BELT is in good condition and loaded properly.

Place the belt in the ammunition chest carefully and be sure that the belt link chute through which the links are ejected is in good condition and in proper alignment.

LOAD the gun, partially or completely, as may be directed.

As soon after a flight as you possibly can, it is important that you do the following:

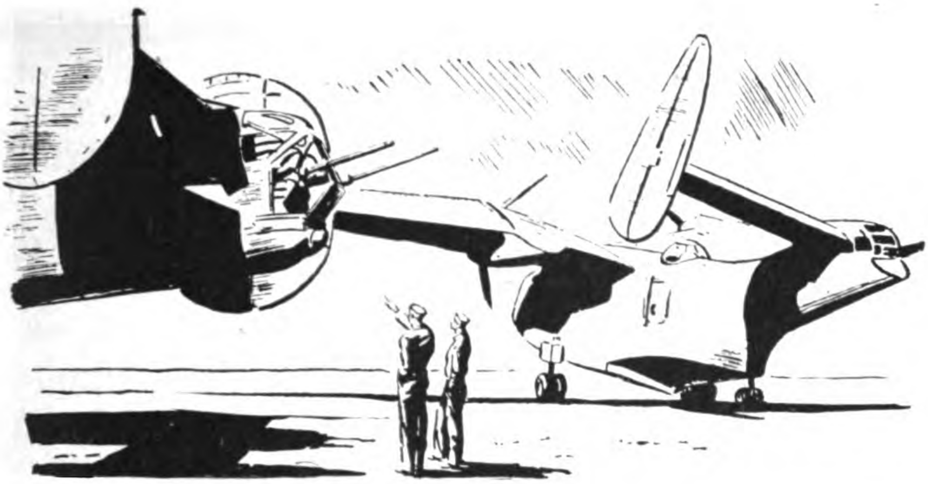
UNLOAD the gun completely and remove the ammunition belt from the ammunition chest.

Clean the BORE and all the working parts. If for some reason you can't do this at once, at least oil the gun carefully to prevent rust.

Release the pressure on the firing pin SPRING.

At the first opportunity, dismount the gun, clean, oil and INSPECT all the parts, and make needed repairs and replacement.

ALWAYS get a detailed account from the gunner or pilot of the gun's behavior in the air. If stoppages have occurred, find out what caused them—and fix them.



CHAPTER 4

20 MM AUTOMATIC

IT PACKS A WALLOP

The heavy artillery of the air is the 20 MM AUTOMATIC GUN. Bigger guns have been mounted in airplanes—the 37 mm and the 75 mm. But for day-by-day use in Navy planes, it's the 20 mm that lands the heavy punch.

The 20 mm is a machine gun, but it is a machine gun with a difference. It's bigger than the BAM—has a bore of nearly an inch. And instead of shooting solid bullets it throws explosive or incendiary SHELLS. Like other aircraft-mounted guns that shoot shells, it is sometimes referred to as a CANNON.

The 20 mm fires a high explosive incendiary shell weighing 0.29 pound, a solid bullet of the same weight, or a solid armor-piercing slug carrying a tracer and weighing 0.37 pound. These are high speed projectiles with a muzzle velocity of 2,850 to 2,950 feet per second and a range of about 5,500 yards. The gun will fire 500 to 800 rounds per minute. It is an AIR COOLED gun and must be fired in short bursts. Since the gun is normally mounted in the wings of fighter or dive

bomber aircraft, it is fired and charged by remote control.

A peculiar feature of the 20 mm gun is that it uses all three types of machine gun operation—blowback, gas pressure, and recoil.

The main operating power of the gun comes from BLOWBACK. That is, the breech is blown open and the bolt thrown backward by the rearward pressure of the expanding gases in the chamber. However, this gun uses high powered ammunition, not the pistol ammunition that blowback-operated submachine guns use. So the 20 mm uses DELAYED BLOWBACK. The breech is locked shut during the period when the gas pressure in the chamber is high. Then, when the pressure has dropped, but before it has entirely disappeared, the breech is unlocked and blown backward.

Unlocking of the breech is accomplished by GAS PRESSURE—the same force which is used to operate the Winchester carbine. There is a hole in the barrel about half way down its length. When the bullet passes the hole, gas rushes through and strikes the gas cylinder sleeve. The sleeve is driven back, and as it moves back it unlocks the breech.

Like any gun with a locked breech, the 20 mm RECOILS during the period when the breech is shut. This recoil movement is used to feed ammunition into the gun.

The whole process sounds pretty complicated, but actually the 20 mm is rather a simple gun—quite a bit simpler than the Browning machine guns you read about in the previous chapter.

THE BOLT AND ITS PARTS

To grasp the detailed workings of the gun, you have to understand the construction of the BREECH BLOCK or BOLT. Figure 35 shows the bolt. The bolt itself is a solid slug of metal which slides back and forth in the receiver. The bolt has a hole running

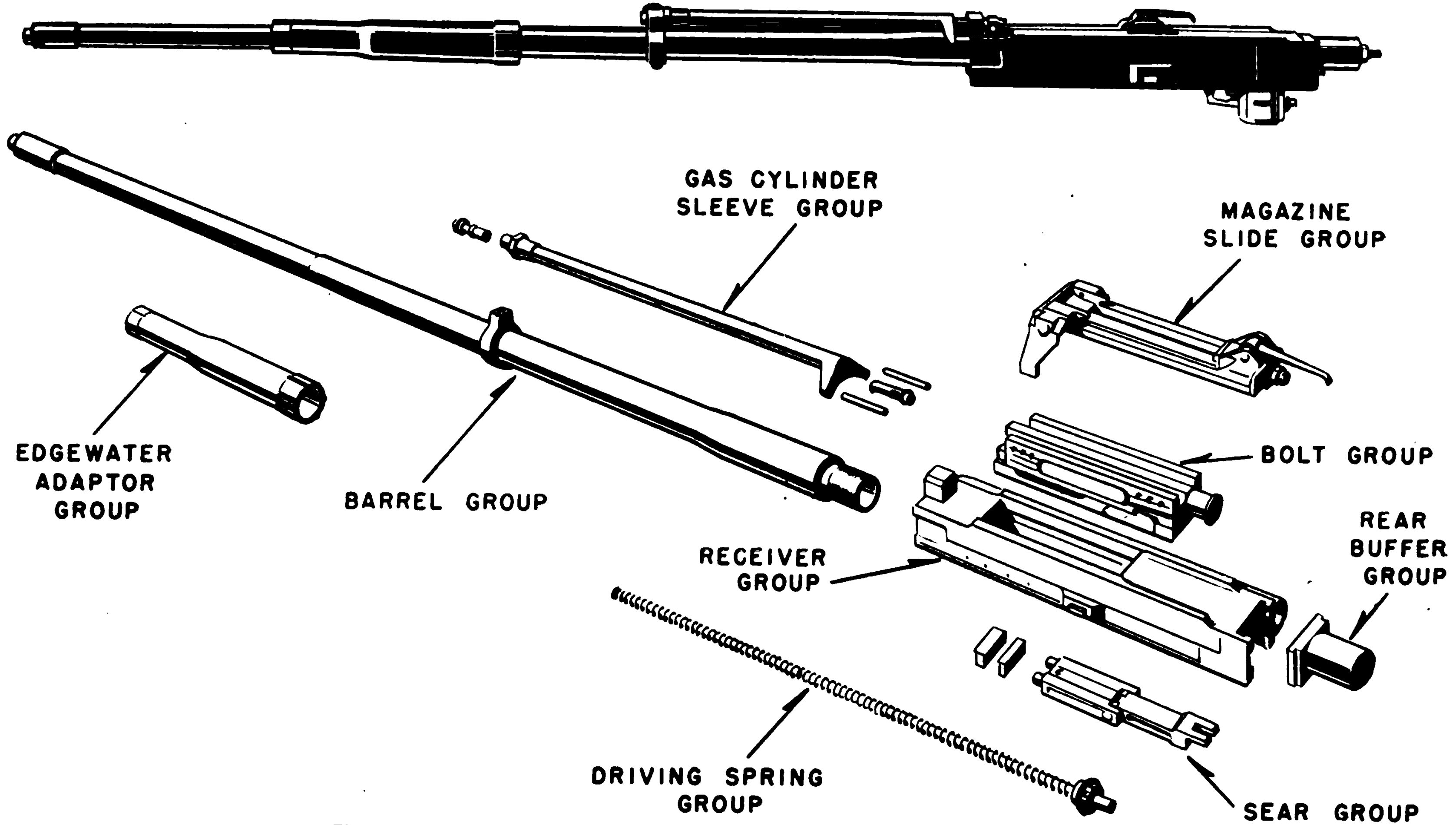


Figure 34.—Disassembly of the 20 mm aircraft automatic gun by groups.

through its center in which the main DRIVING SPRING and the FIRING PIN are mounted. A slot aft

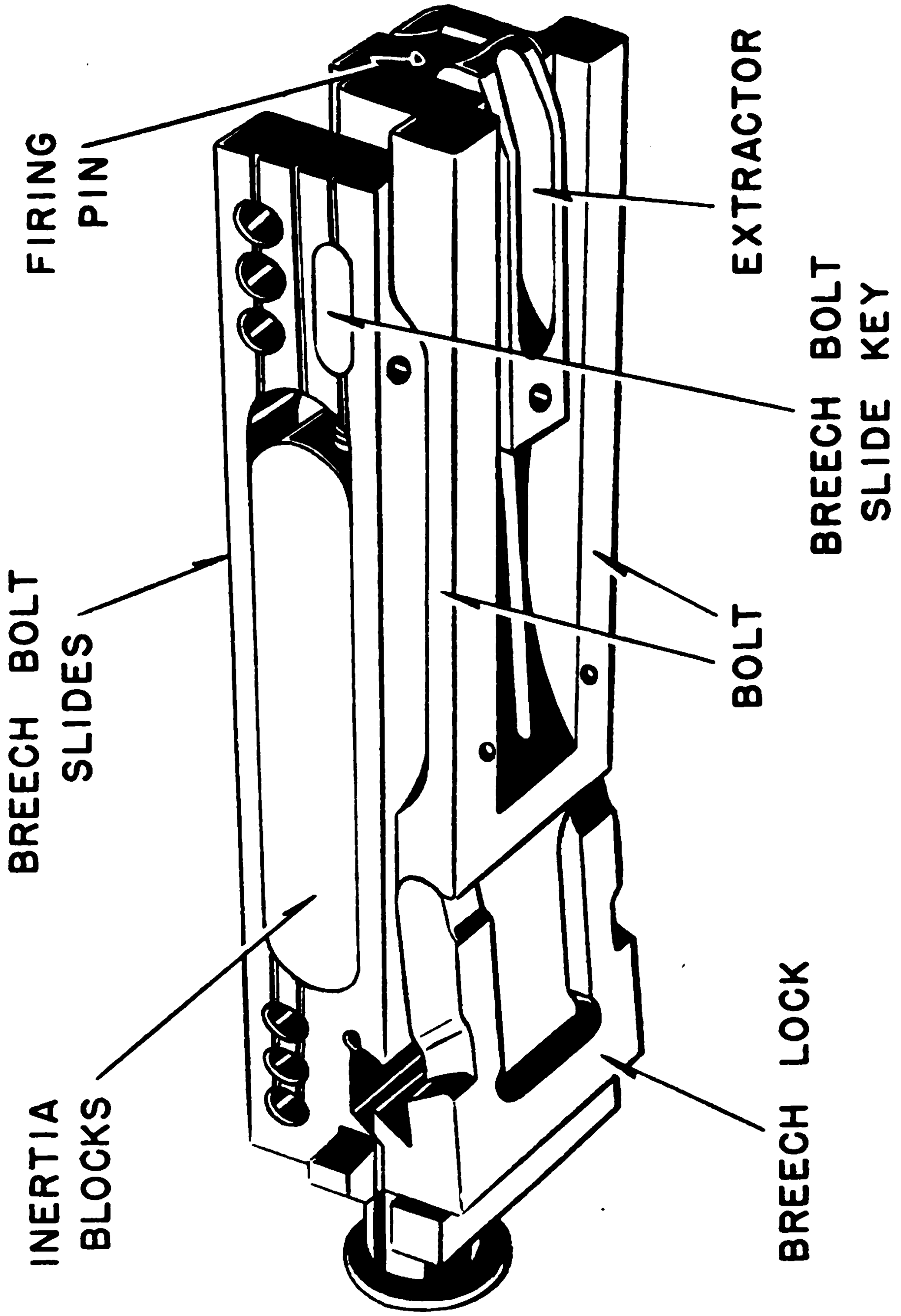


Figure 35.—Breechblock assembly of the 20 mm. Aircraft automatic gun, AN-M2.

on the underside provides space for the BREECH LOCK.

The lock is a flat plate, rounded at its forward edge where it butts against a matching face of the

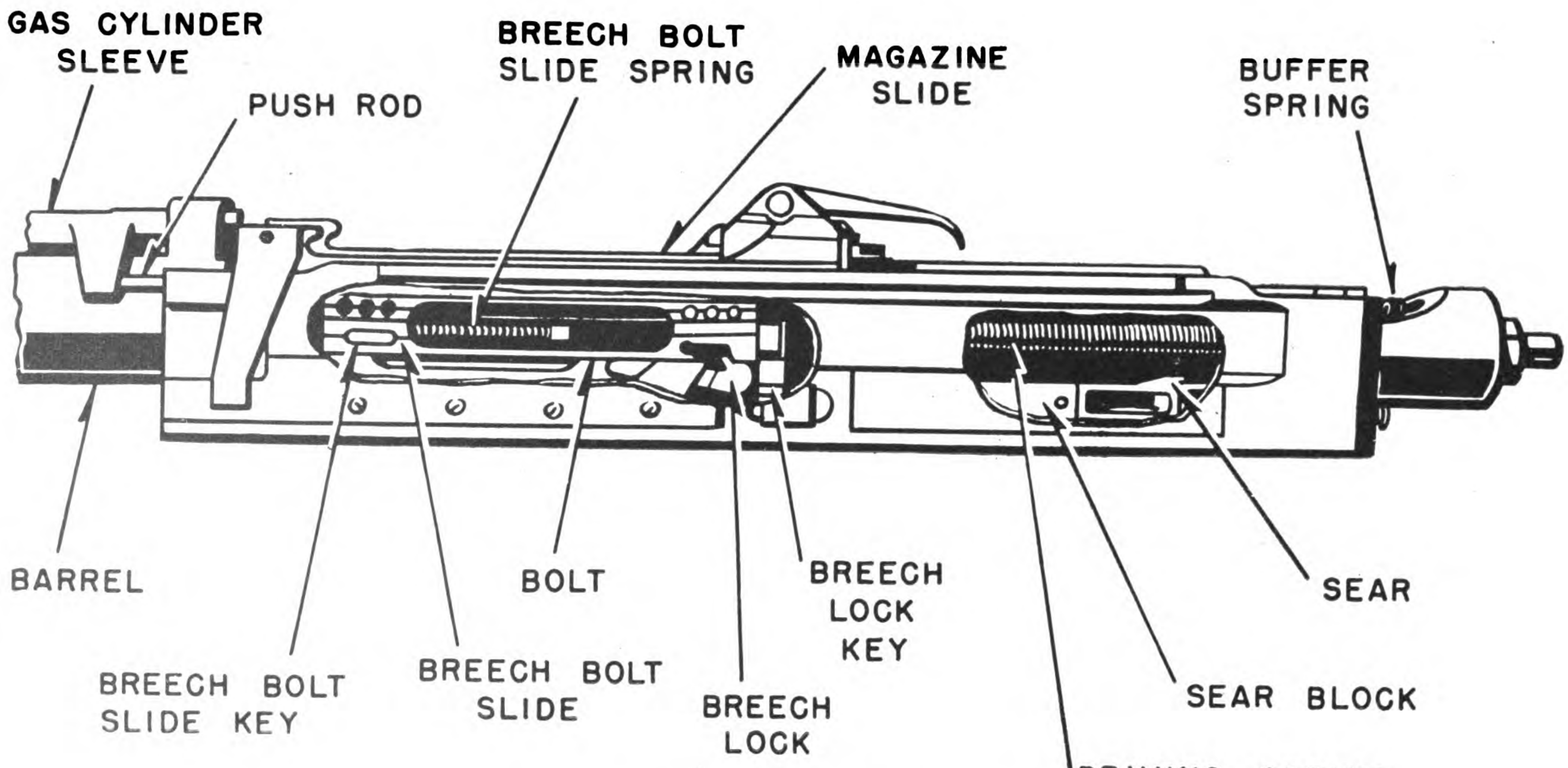


Figure 36.—Receiver of 20 mm cut away to show action.

slot in the breech bolt. It can roll up or down on this surface. In the cutaway section of figure 36, you can see how the lock looks from the side. Here the lock is in the locking position. It has dropped down into a slot in the floor of the receiver. You can see that as long as it is down there, the bolt cannot move back. The breech is LOCKED. If the lock should pivot upward out of the slot of the receiver, the breech would be unlocked. Notice, in figure 35, the slanting projection on the upper side of the lock.

Riding in slots on the side of the breech bolt are the two BREECH BOLT SLIDES. They are connected together by the BREECH BOLT SLIDE KEY, a metal bar which runs through a slot cut in the forward end of the bolt. This slot is wide enough to permit the slides to move backward and forward along the bolt for a short distance. SLIDE SPRINGS, which bear against projecting lugs on the bolt, keep trying to push the slides forward.

The FIRING PIN rides in the central hole running lengthwise through the bolt. You can see the pin in figure 37. Notice that it has a groove in its side. This groove fits over the breech bolt slide key, so that as the slides move back and forth, the firing pin moves with them.

Now notice, if you will, the slanting notch cut into each of the breech bolt slides. You can see how the slanting projection on the breech bolt lock extends up into this notch. Suppose, in the gun pictured, the slide should move backward. Then the slanting face of the notch would strike against the slanting projection on the lock. The lock would ride up the cam surface and be lifted out of the notch in the floor of the receiver.

In other words, a backward movement of the breech bolt slides will UNLOCK the breech.

There are two other important parts of the breech bolt. The EXTRACTOR is a claw which is

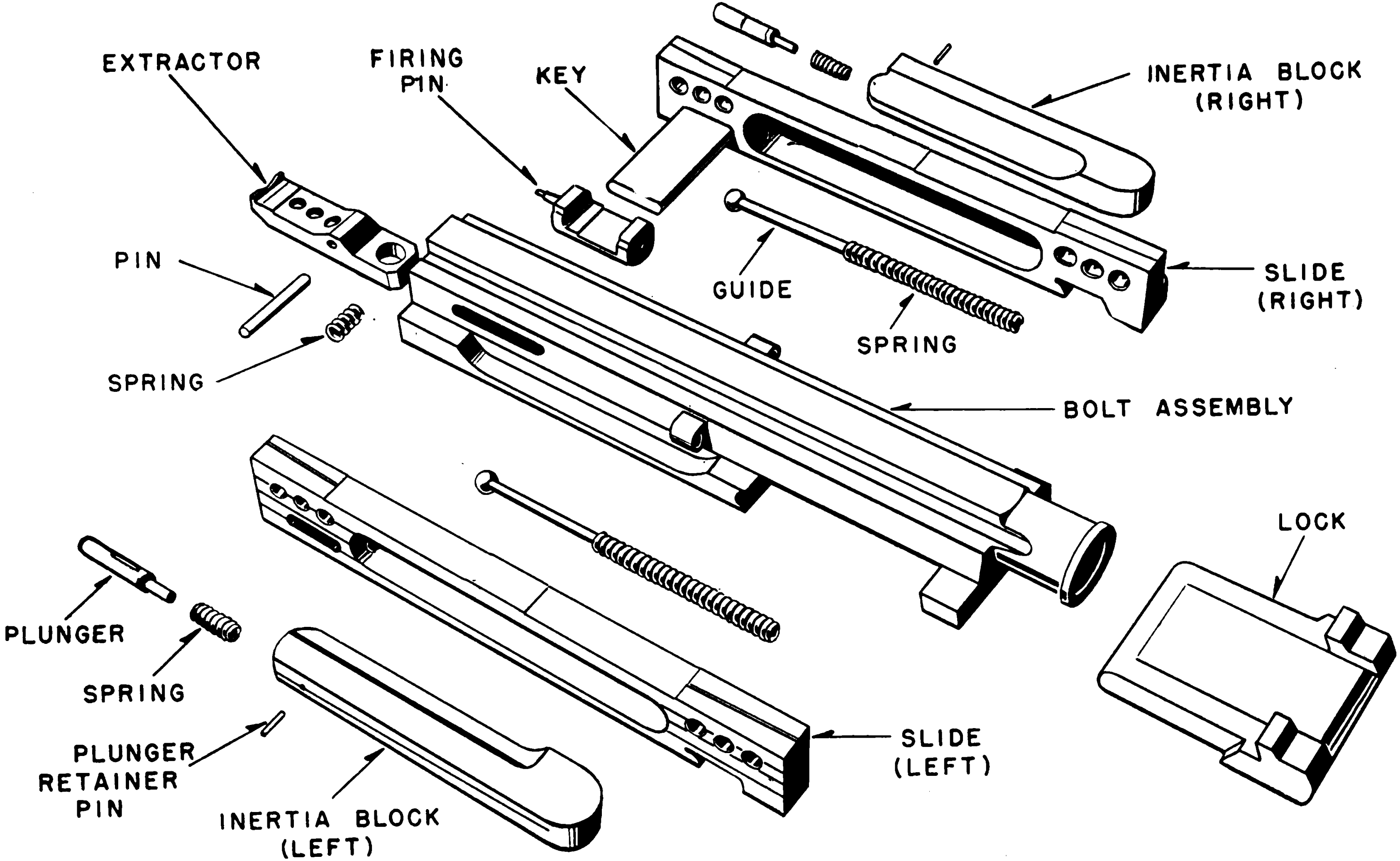


Figure 37.—The breech bolt group.

pivoted to the underside of the bolt at its forward edge. This claw has a small spring which makes it snap over the end of a cartridge case.

The INERTIA BLOCKS, whose purpose you will discover later, fit into the long slots in the slide and can slip back and forth in them a short distance. In figure 36, the inertia blocks have been removed to show you the slide springs. You can see them in figure 37.

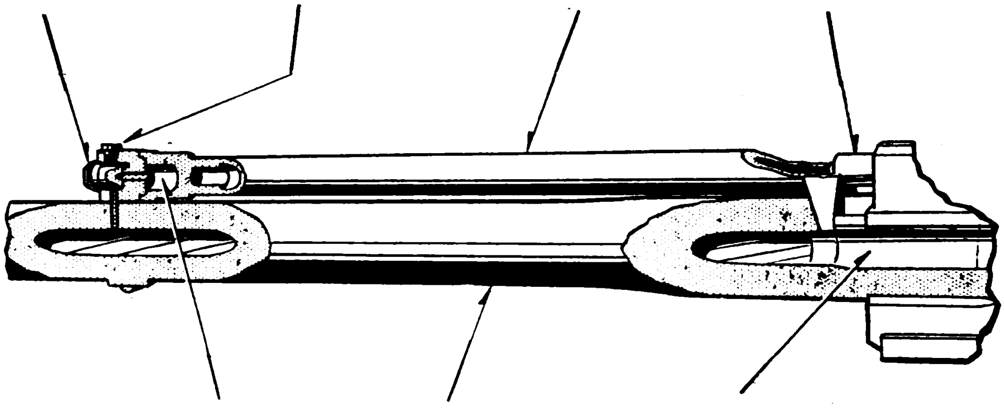


Figure 38.—Cutaway view of gas cylinder group.

You have seen that the breech of the 20 mm gun can be unlocked by forcing the breech block slide to the rear. How are the slides moved?

Look at the cutaway view of the gas cylinder group in figure 38. You can see that when the shell has moved down the barrel past the GAS CYLINDER VENT, gas under pressure will pass through the vent and into the GAS CYLINDER. There the pressure will drive the GAS CYLINDER SLEEVE rearward. Although it does not show in the picture, there is a spring inside the sleeve. This spring is compressed as the sleeve moves aft. The sleeve group is shown disassembled in figure 39.

Attached to the after end of the sleeve is a YOKE which presses against two PUSH RODS. These push rods run through holes in the front of the receiver

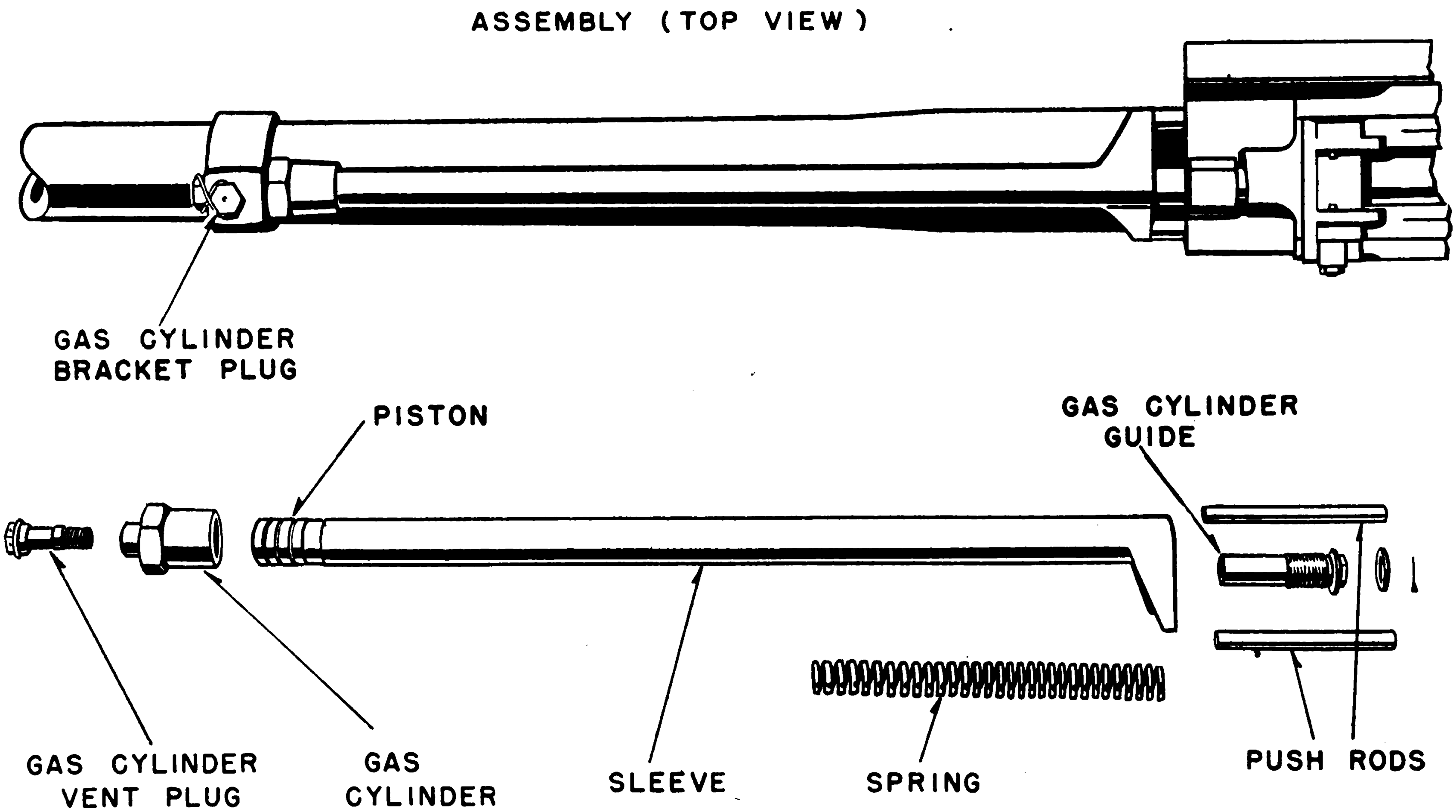


Figure 39.—The gas cylinder sleeve group.

and butt against the upper outside corner of the slides. Thus, as the sleeve moves back, the push rods are pushed in, and the slides are moved to the rear—unlocking the breech.

Notice that by the time this unlocking action occurs the shell is nearly out of the muzzle, and the CHAMBER PRESSURE has dropped sufficiently to make it safe to unlock the breech. At the same time, there is still plenty of pressure left to drive the bolt to the rear.

HOW THE GUN WORKS

What happens when the gun operates? First the gun must be charged. Mounted along one side of the receiver is a tube in which a HYDRAULIC CHARGING MECHANISM can be installed. This consists of a cylinder and piston. When hydraulic pressure is admitted into the cylinder by a valve in the pilot's cockpit, the piston is pushed to the rear. The piston bears upon a lug protruding from the right hand breech block slide through a slot in the side of the receiver. The piston presses the lug back. As the slides are pushed back, they cam the breech lock upward, unlocking the breech block.

The slides are now as far back on the block as they can go, and further movement of the hydraulic charger moves the whole block aft. Notice that as soon as the bolt has moved backward, the breech lock is held in its raised position by the floor of the receiver. This locks the slides—and the FIRING PIN which is keyed to them—in their rearward position on the bolt, because the projection on the top of the lock is extending up into the notches on the slide. See figure 40.

The DRIVING SPRING extends from the back plate of the receiver forward through the hole in the bolt and bears against the after end of the firing pin. As the bolt is pushed aft by the hydraulic charger, the driving spring is compressed.

When the bolt is all the way back, it is held cocked by the SEAR. The sear is a simple hinged latch which is pushed upward by a spring. As the bolt comes back, the sear snaps into a notch on the underside of the bolt lock and holds it in the retracted position.

Now the gun is ready to fire. An ELECTRIC TRIGGER is used to fire the 20 mm by remote control. This is simply a solenoid fastened to the underside of the receiver. When the current is passed

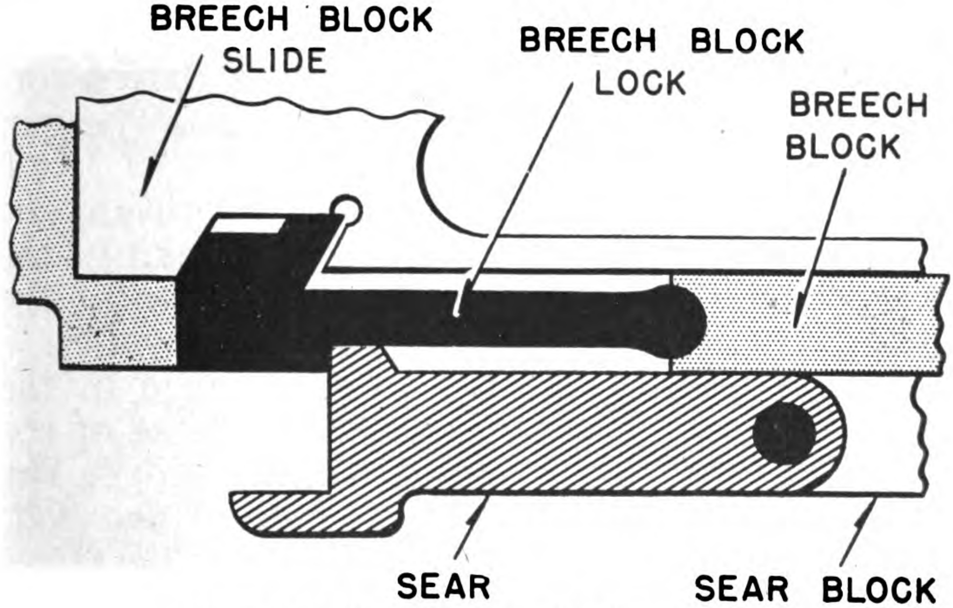


Figure 40.—How the sear holds the bolt back.

through the solenoid, it pulls the sear downward against the sear spring. This releases the bolt. The driving spring presses against the firing pin, which is keyed to the breech bolt slides, which are locked to the bolt by the breech bolt lock. So the whole assembly slides forward.

Meanwhile, the feed mechanism—which will be described later—has fed a cartridge into the action in front of the bolt. The bolt picks up the cartridge, the extractor snaps around the flange on the cartridge, and the round is shoved home into the chamber.

At this instant, the breech bolt lock has come to the notch provided for it in the receiver floor. Nothing is now holding it up, and the pressure of the spring on the firing pin drives the firing pin and the slides forward. The notches on the slide cam the lock down into its recess and lock the bolt.

To make doubly sure that the breech bolt block will be forced down, two cams are mounted on the RECEIVER SLIDES fastened to the sides of the receiver. Projections on the sides of the lock strike against the slanting cam surfaces of the receiver slides as the bolt moves forward, and the lock is cammed downward. As the firing pin drives forward, it hits the primer of the cartridge. The gun fires.

The INERTIA BLOCKS now operate to prevent the slides from bouncing back and unlocking the breech. They jump forward in the slides, hit the forward face of the slides, and kill the bounce.

The explosion of the propelling charge in the cartridge presses forward against the base of the bullet and presses back against the cartridge. The cartridge is driven against the face of the bolt, but the bolt is locked and does not move.

The shell moves down the barrel. When it passes the gas cylinder vent, gas escapes into the cylinder, driving the sleeve and its yoke backward. The yoke pushes the push rods inward. They push against the slides—driving them back and unlocking the bolt.

The remaining gas pressure in the chamber now drives the cartridge and the unlocked bolt backward, compressing the driving spring. When the bolt has traveled far enough back to clear the cartridge out of the chamber, the upper side of the cartridge strikes a pair of projecting prongs known as the EJECTOR. This causes the cartridge to pivot around the extractor and shoot out the underside of the gun. The bolt continues to move

backward until it strikes the REAR BUFFER—a powerful spring attached to the back plate of the receiver. You see the parts in figure 41.

The rear buffer stops the bolt, then starts it forward again. If the sear is still held down, the bolt will drive forward, picking up a fresh round, and repeating the whole process.

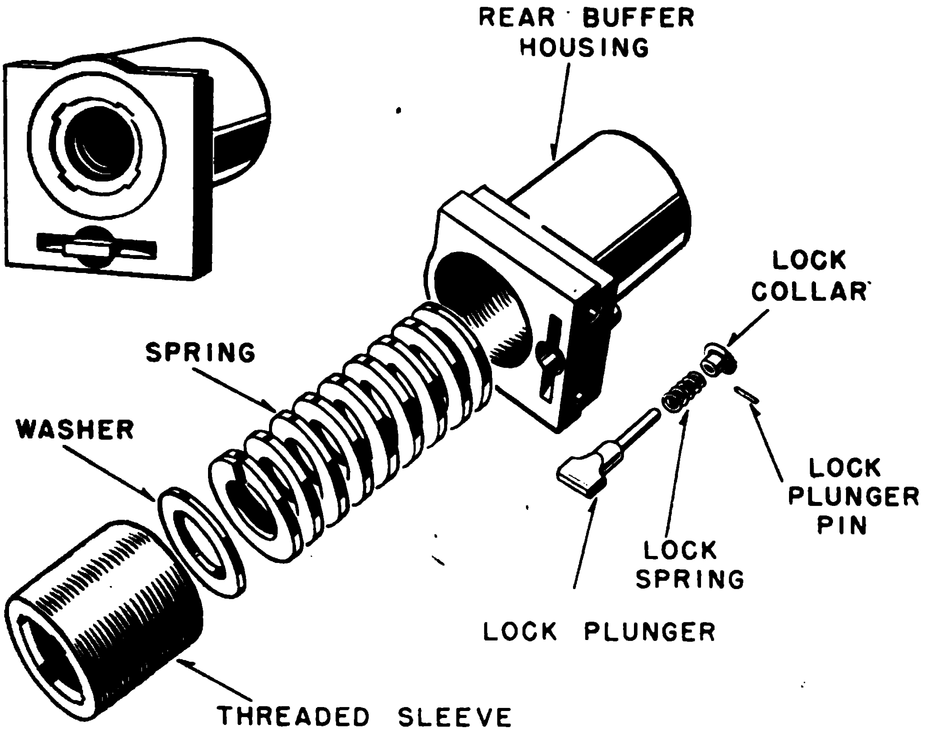


Figure 41.—The rear buffer group.

If the trigger has been released, it will snap into the slot under the bolt as the bolt starts forward. The bolt will be held in the retracted position, stopping the gun.

There is quite a shock as the sear catches the bolt. To cushion this shock the sear is hinged to a separate piece called the SEAR BLOCK instead of being hinged directly to the receiver. The sear block can slide in grooves in the receiver and is held in position by two powerful springs. These springs take up the shock when the sear catches the bolt.

FEEDING THE AMMUNITION

The only thing that remains now is to see how ammunition is fed into the gun. The 20 mm is ordinarily fed—like a BAM gun—from belts of cartridges fastened together by metal links. This belt is pushed into a feed mechanism mounted on top of the receiver. The first cartridge is engaged by the sprocket wheels which you can see in figure 42. A powerful coil spring at one end of the feed mechanism is trying to drive these wheels around.

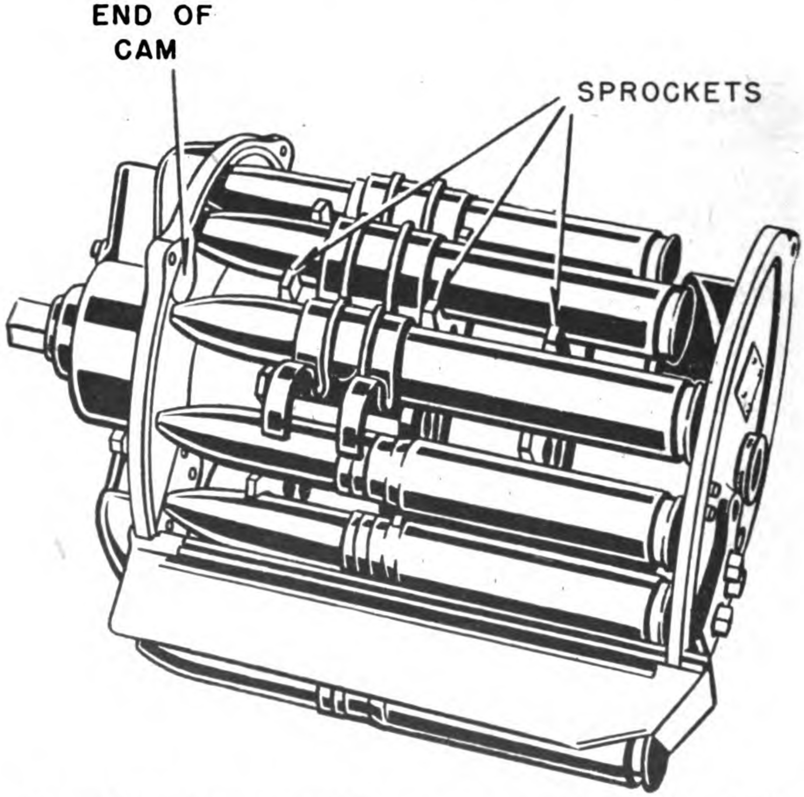


Figure 42.—How the cartridges are cammed out of the belt.

They pull the belt into the feed mechanism and around to the mouth leading into the action. As the belt is pulled in, the end of each shell presses against a slanting track on the forward edge of the feed mechanism. As the cartridge moves around, this track forces the cartridge backward out of the link of the belt. When the cartridge gets to the bottom of the mechanism, it is completely

free from the link. The link drops out to one side, and the first cartridge in the belt is fed down into the action.

As the action of the gun picks up each cartridge and rams it into the chamber, the spring tension acting on the sprocket wheels feeds a fresh cartridge into its place.

When the gun is made ready for firing, the spring in the feed mechanism is wound up by hand. But it must be kept wound as the gun fires. The recoil of the gun is used to wind the spring.

Here's how it's done.

When the gun fires, the breech bolt is locked to the receiver. So the whole mechanism—barrel, bolt, and receiver—kicks backward. This kick is resisted by a spring device called the EDGEWATER ADAPTER which you can see fastened to the barrel of the gun about midway of its length in figure 34. One end of the Edgewater adapter is fastened to the barrel, while the other end is fastened to the frame of the airplane. Between the ends are two powerful springs, placed end to end. One of the springs, though strong, has some flexibility. The other is extremely stiff. When the gun starts to recoil, the weaker spring takes up the shock and permits the gun to move back about .75 inch. That is all the compression of which this spring is capable, and the stiff spring now picks up the movement. It is so stiff that the gun can only move about another .25 inch and then is stopped. Then the two springs work together to return the gun to battery.

Thus, with each shot, the gun springs back about an inch and springs forward again.

The feed mechanism is latched to a piece known as the MAGAZINE SLIDE which rides in grooves on the top of the receiver. The magazine slide is fastened to the frame of the airplane. As the gun fires, the receiver moves back and forth under the

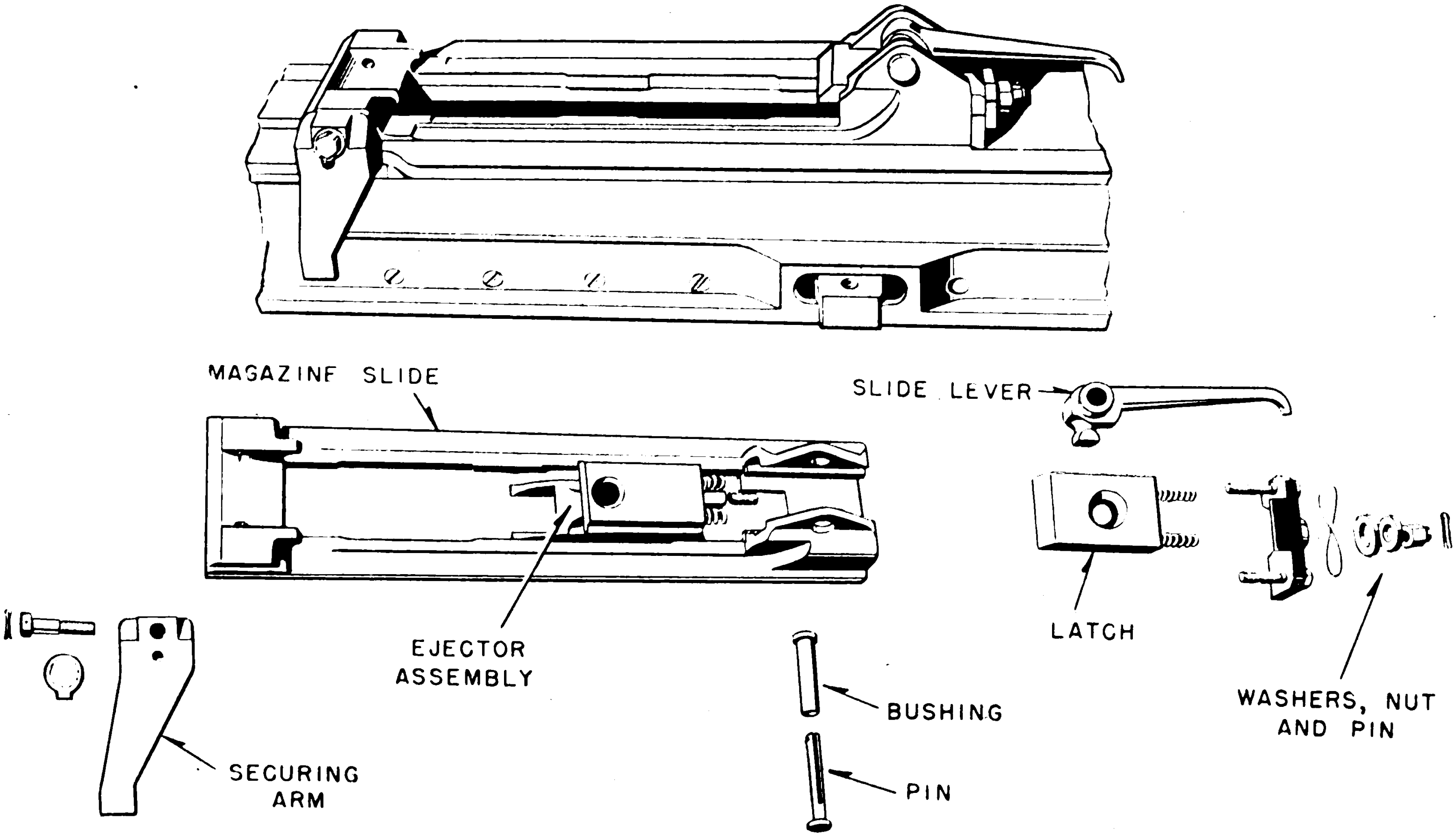


Figure 43.—The magazine slide group.

slide. As the receiver moves back and forth, a small vertical shaft in the magazine slide is cammed up and down. By a ratchet arrangement, this shaft cranks the spring-winding gear around, constantly winding the mainspring of the feed mechanism. Thus, the feed mechanism is kept constantly wound as long as ammunition remains in the feed belt.

Some models of the 20 mm gun are fed by a spring-driven drum-type MAGAZINE containing sixty rounds. In this case the magazine is wound sufficiently at the start to feed the entire 60 rounds, and no use is made of the recoil of the gun. However, belt feed is now the most common method.

MAINTENANCE OF THE 20 MM

Maintenance of the 20 mm aircraft gun is just about the same job as maintaining a machine gun. But there are a few special rules to remember.

When the gun is not in use, the breech block should always be kept in the CLOSED position. Never leave the gun in the cocked position and never try to work on the gun when it is cocked.

NEVER put your hand in front of the bolt while it is in the cocked position.

When assembling the gun, always apply a mixture of flake graphite and castor oil to the GROUND THREADS by which the barrel is screwed into the receiver.

After assembling, always check the gun by allowing the breech block assembly to go forward under driving-spring pressure against an empty shell case in the cartridge chamber. NEVER let the breech block go forward under spring pressure without having an empty shell in the chamber.

One important caution. You will often have to find out the cause of a misfire or jam of the gun. In such a case, ALWAYS WAIT 5 MINUTES before

opening the gun. There may be a HANG FIRE present. In such a case, the cartridge may explode some seconds or minutes after the firing pin has struck it. You might get an explosion in your face when you open the breech.

Also, if the barrel is hot, you may get a cooked-off round. In this case, the heat of the barrel gradually heats up the cartridge until the propellent charge explodes. A wait of 5 minutes will give the barrel time to cool off.

Besides waiting 5 minutes, be sure to remove the MAGAZINE and any cartridges that may be partly positioned and to set the SAFETY LEVER in the "on" position before you charge the gun.

CHAPTER 5

RACKS AND SHACKLES

THEY LAY THE EGGS

People sometimes call airplanes battleships of the sky. If that's what they are, then bombs are the big guns of the aerial battleships. Or rather, the bombs are the shells—the big guns are the racks and shackles that "fire" the bombs or "eggs" as they've come to be known these days.

Actually, of course, a bomb isn't fired—it is dropped. So a rack or a shackle is a very different thing from a gun. Essentially these racks and shackles are just hooks from which a bomb can be hung—and which can let go of the bomb at the right moment.

Racks and shackles—they are very nearly the same thing—have three main jobs.

They have to CARRY the bombs while the plane is in flight.

They have to DROP the bomb at the right moment.

And they have to ARM the bomb.

You probably know already that bombs carry FUZES to make them explode. When a bomb is

dropped from a plane the fuze is SAFE—it will not go off if it hits the ground. But as the bomb falls, the little propellers or arming vanes on the fuze spin, and as they spin they bring the fuze to an ARMED condition—a condition in which it will go off when it hits. While the bomb is in the plane, the arming vanes cannot turn because a wire—the arming wire—is threaded through the vanes and fouls them. If the bomber drops his bombs and wants them to explode, he must pull the wire out. This is called dropping the bombs "armed."

If the bomber wants to get rid of the bombs but does not want them to explode, he leaves the arming wire in the fuze. This is called dropping the bombs "safe."

Thus the racks and shackles have to be equipped so that the bomber can drop the bombs armed or safe, as he wishes.

Racks and shackles are located in different places in different airplanes. Sometimes they are fastened to the underside of the wings. Then the bombs are suspended right out in the air. Some airplanes have BOMB BAYS inside the fuselage where the bombs are carried—either fastened to the side walls of the bomb bay or to the top of the bay. Most Army bombing planes have bomb bays and so do Army-type planes which the Navy uses—such as the PB4Y Liberator, or the PBJ Mitchell.

Whether the bombs in the airplanes are suspended from racks or from shackles depends upon their location. Racks are solidly and more or less permanently attached to the main structure of the airplane. They are used when bombs are suspended from the underside of a wing or from the top of a bomb bay.

When bombs are hung from the side of the bomb bay they need some kind of hinged connection. Shackles can be easily detached from the

airplane. Often a shackle is fastened to a bomb before the bomb is hoisted into the airplane. After hoisting, the shackle is hooked to the plane.

This is the only important difference between a rack and a shackle. The internal workings—the devices for suspending, releasing and arming the bomb—are just about the same.

HOW A RACK WORKS

The simplest form of bomb rack consists of two side plates joined by spacers and rivets with an arrangement for attaching the rack to the airplane structure. The rack contains one or two hooks on which the bomb is hung, and some sort of a device for opening the hooks. Sometimes this device is operated by a set of control cables running to a lever in the bomber's compartment. This sort of arrangement is called MANUAL release.

Or, the release mechanism may be operated by an electric solenoid attached to the rack. If that's the case, electric wires will run from the solenoid to the bomber's compartment, and he can operate the rack by pressing a switch. This is called ELECTRICAL release.

The arming mechanism on the rack consists of a special hook called the arming wire RETAINER. One end of the arming wire is fastened to the retainer. The retainer can be set so that it will hold the arming wire very LOOSELY. Then when the bomb is dropped the wire will pull away from the retainer and fall with the bomb. In this condition the rack is set for "safe" release.

If the bomb is to be armed, the retainer can be set to hold the arming wire FIRMLY. Then when the bomb is dropped the wire will stay fastened to the rack. The bomb will pull away from it, and the arming vanes of the fuzes will be free to spin.

Racks are armed and safetied either manually or electrically or both.

Some racks have TWO arming wire retainers, one for each of the fuzes in the bomb. The bomber then can arm one fuze, if he wishes, and not the other. This is called SELECTIVE ARMING.

When a bomber is getting ready to drop a bomb, he first sets the arming levers or switches to the armed or safe condition. Then, at the moment the bomb is to be released, he pulls the release lever or presses the release switch. In an airplane using a BOMBSIGHT, the bombsight itself throws the release switch automatically at the right moment.

You can get a general idea of what makes a rack work from figure 44. Notice that the WEIGHT OF THE BOMB will tend to rotate the bomb suspension hooks. If this were allowed to occur uncontrolled, the bombs would be released prematurely.

Now, look at the AFTER BOMB SUSPENSION HOOK. It is pivoted about point *A*. It is prevented from rotating by the RELEASE PAWL and the RELEASE PAWL LINK. These two pieces are pivoted together at *C*, but as long as they stay in a straight line, they form a solid brace from *B* to a pivot point *D*. The suspension hook is trying to turn at all times. So the release pawl tries to swing downward, pivoting at point *B*, which would get it out of line with the release pawl link. A spring, which is not shown in the drawing, is also trying to push the release pawl downward.

But the release pawl cannot swing downward because the RELEASE LEVER butts against it and holds it up.

When the rack is operated ELECTRICALLY, a current is passed through the RELEASE SOLENOID, and the solenoid pulls the release lever forward out of the way of the release pawl. The release pawl swings downward, permitting the after suspension hook to rotate. The forward suspension hook is connected to the after hook by the HOOK CONNECTING LINK, so the two hooks operate together.

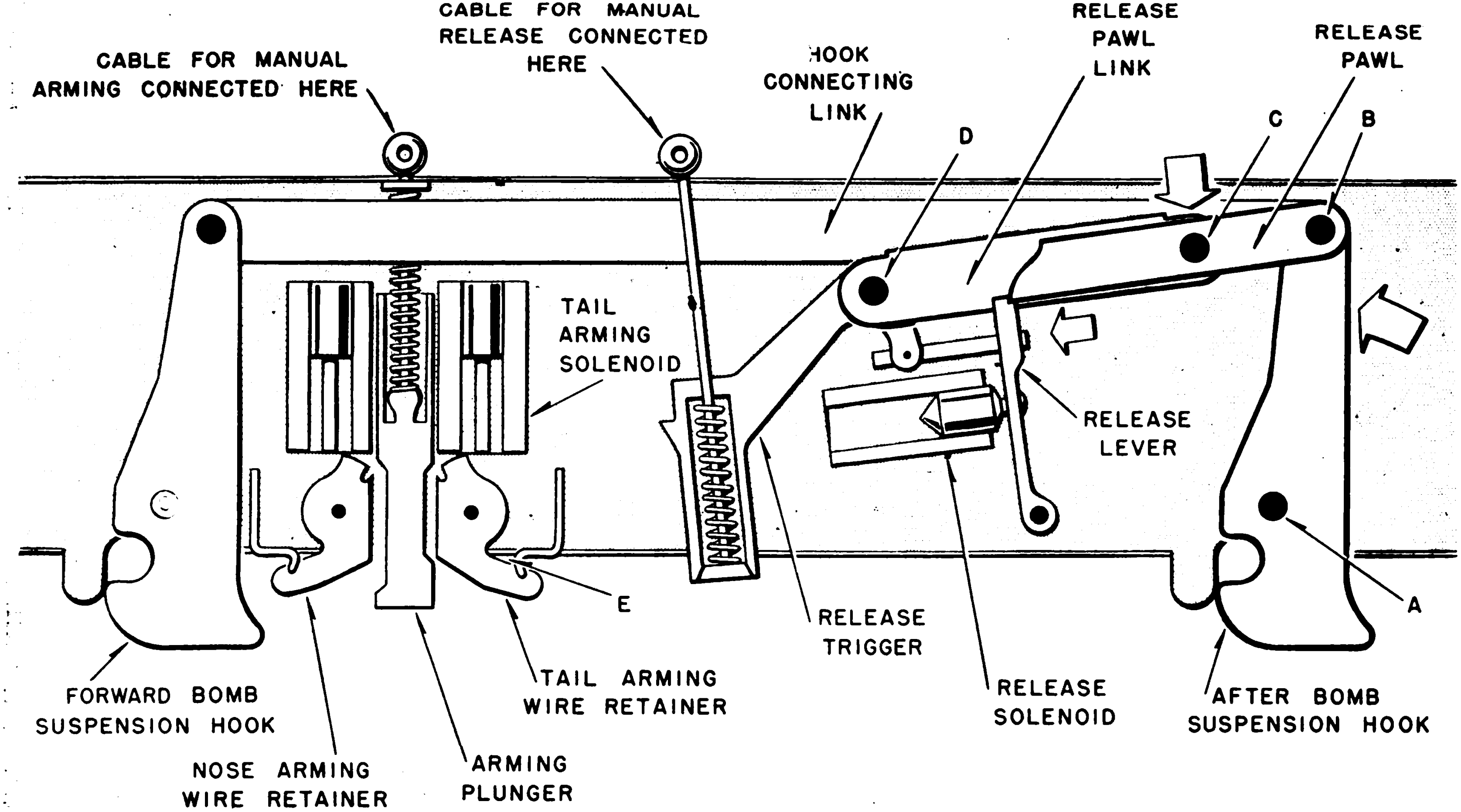


Figure 44.—This drawing, which omits some details, shows how a Mk 51 bomb rack works.

When the rack is operated MANUALLY, the RELEASE TRIGGER is rotated about point *D* by a pull on the cable. This pulls the release lever forward and drops the bomb.

Notice the ARMING mechanism in the center of the drawing. The brass plates on the end of the arming wire are slipped under the ARMING WIRE RETAINERS at point *E*. The retainers are free to rotate, resisted only by a light spring, so that any pull on the arming wires would snap them out from under the retainers. The rack is therefore in a SAFE position.

Now for the ARMING PLUNGER. Notice that there are grooves on each side of it which, in the drawing, permit the retainers to rotate. If the arming plunger is pulled UPWARD a short distance manually, the solid portion of the plunger will foul the tail retainer. Therefore, the TAIL FUZE will be armed.

The nose retainer will still be free to rotate and the NOSE FUZE will still be safe.

If the plunger is pulled FARTHER upward both the nose and tail retainers will be fouled and BOTH FUZES will be armed.

ELECTRICAL operation of the arming mechanism is accomplished by the two solenoids. When either solenoid is energized, it pushes a plunger downward and thus fouls the projection on the upper side of the retainer—preventing the retainer from rotating. Since the two solenoids are wired independently, EITHER fuze or BOTH can be armed.

Electrical equipment on bomb racks is built for either 12-volt or 24-volt operation. The voltage of the bomb rack is always stamped on the name plate. You MUST use a rack of the same voltage as the operating circuit of the airplane.

KNOW YOUR RACKS

Quite a number of different racks are now used

on Navy airplanes—some with one suspension hook and some with two. Here are the ones you will run into most frequently:

The two-hook rack you will find on the Navy's newest planes is the Mk 51, (fig. 45). This has two suspension hooks spaced 14 inches apart and will carry any two-lug bomb weighing between 25 and 1,600 pounds. The bombs can be released both manually and electrically.

ARMING of the Mk 51 is also both manual and electrical. Electrical arming is completely SELECTIVE—this means that you can arm either the tail fuze, or the nose fuze, or both or neither. MANUAL arming is semi-selective. You can arm the TAIL FUZE ONLY, or you can arm both fuzes. Manually, you can't arm the nose fuze alone.

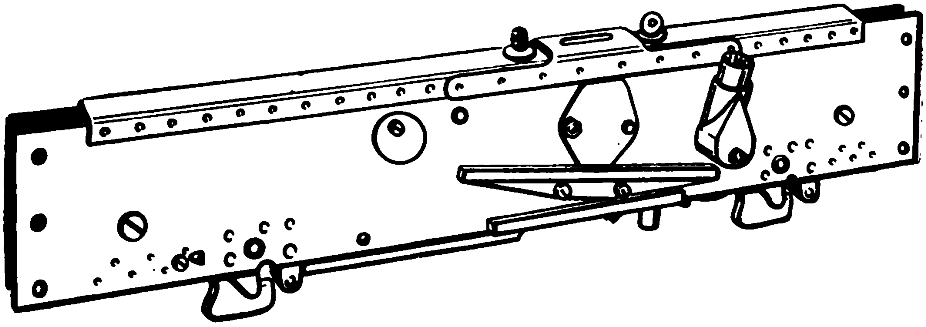


Figure 45.—Bomb Rack, Mk 51 Mod 5.

The solenoid for electrical release is housed between the side plates of the Mk 51 rack. The electrical connection is made through a receptacle which mates with a plug mounted in the airplane. Manual release is accomplished by a bomb release handle mounted in the cockpit and connected to the rack by a cable. This cable, and the arming cable, are attached to the eyelets visible at the top of the rack.

MARK 35 RACKS

On OLDER airplanes you're likely to encounter another two-hook rack—the Mk 35. Although the

Mk 35 is no longer manufactured (its place has been taken by the Mk 51), there are still a good many of them in use. The gear for mounting the Mk 35 and Mk 51 racks is interchangeable, and so is the manual arming and releasing equipment.

The Mk 35 rack was originally designed for MANUAL operation only. It is usually converted to permit electrical release by installing a special release solenoid at the top of the rack between the side plates.

The arming arrangements are MANUAL and NON-SELECTIVE. The rack has only one arming wire retainer, to which both arming wires run. So

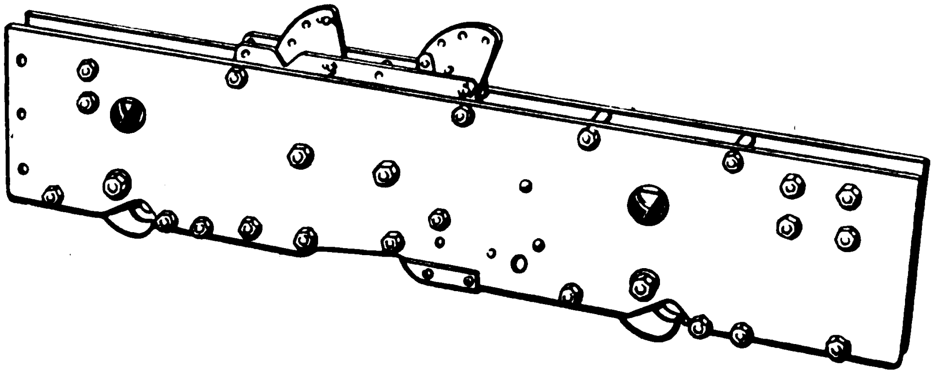


Figure 46.—A Mk 35 bomb rack.

all the fuzes are armed or all are safe. Again, however, the rack can be CONVERTED to electrical selective arming. This is done by attaching BOMB FUZING CONTROL BOXES to the side of the rack or the airplane structure nearby. These are separate arming wire retainers electrically operated. By using two of them, completely selective arming can be obtained.

The Mk 35 rack cannot handle the same range of BOMB SIZES as the Mk 51. It will not operate reliably with bombs weighing LESS than 100 pounds, because the rack depends for its operation upon the weight of the bomb. Also the Mk 35 is not strong enough to carry bombs weighing MORE than 1,000 pounds.

SINGLE-HOOK RACKS

Smaller bombs are frequently suspended by a single hook instead of by two hooks. This is common with 100-pound bombs, small gear such as pyrotechnic FLARES, and the 325-pound DEPTH BOMBS.

For single-hook suspension, the Navy uses the Mk 50 rack on its modern planes. The Mk 50 is almost identical with the Mk 51 except that it has only one hook. Also, it has adjustable steadying forks fore and aft which rest against the top of the bomb and prevent it from swaying. It will carry bombs weighing between 25 and 500 pounds.

Like the Mk 51 the Mk 50 has manual or electric release, manual semi-selective arming, and completely selective electrical arming.

You will also find an OLDER single-hook rack on Navy planes, the Mk 41. This is designed to take only a 100-pound bomb, but a REINFORCING PLATE can be fastened to the top of the rack, increasing its maximum capacity to 400 pounds. Like the Mk 35, the Mk 41 is basically designed for manual operation. You can convert it to electrical selective arming in the same way by installing bomb fuzing control boxes.

Because the rack is intended to be used only for small bombs, it has no arrangements for attaching a bomb hoist.

Both the Mk 41 and Mk 35 are easily fouled by pebbles or dirt getting inside, and they must always be checked over carefully before use. After use, they should be washed with fresh water, especially if they have been exposed to salt spray.

PRACTICE RACKS

Navy bombers don't spend all their time dropping bombs on the enemy. They have to PRACTICE. And for many types of practice, special racks are used.

There are two quite different ways in which a bomber practices. He may use FULL-SIZE bombs—sometimes regular service bombs and more often sheet metal bombs filled with sand or water. In this type of bombing, of course, it is practical to use a regular service rack if a service type airplane is being used. However, in planes which are only used for practice, the Mk 42 rack is frequently used. This was formerly a service rack but is now only used for practice.

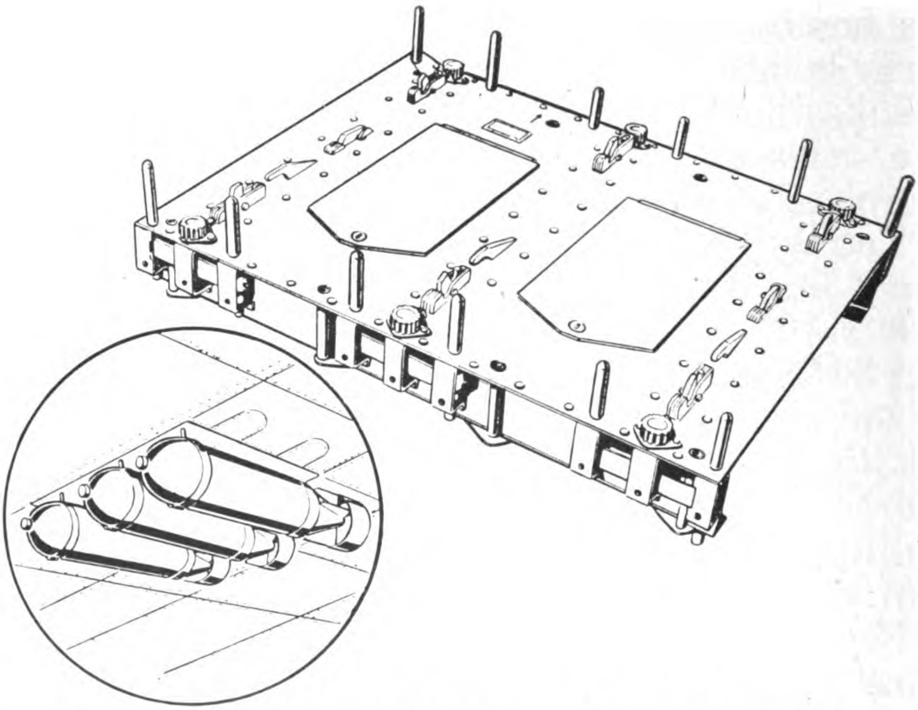


Figure 47.—This Mk 42 rack, which holds three 100-pound bombs, is now used only for practice.

The Mk 42 rack carries THREE 100-pound service bombs or three practice bombs. It is constructed in a rectangular shape with a solid plate bottom through which the hooks and steadying forks protrude. Three built-in solenoids permit selective electrical release. Salvo release—all the bombs at once — can be accomplished manually. All the bombs in the rack are armed simultaneously, either manually or electrically.

Another way in which bombers practice is by dropping so-called MINIATURE PRACTICE BOMBS. These are little lead or iron slugs, tear-drop shaped and weighing 4 to 13 pounds. They are designed to drop with just the same trajectory that a full-size bomb would follow, and they carry SPOTTING CHARGES of black powder which explode with a puff of smoke when the bombs land.

For DIVE BOMBING practice with miniature bombs, the Mk 47 rack (fig. 48) is now used. It is a long cigar-shaped metal box which holds eight miniature bombs in separate compartments. It drops the bombs one at a time, ELECTRICALLY. There is a manual release cable in the rack, but it is intended only for testing.

This rack has suspension lugs on it so that it can be hung from the standard service racks on the plane. What makes it especially suitable for dive bombing is that the bombs are not simply dropped —they are THROWN clear of the plane by a spring.

An older rack which is sometimes used for dive bombing is the Mk 43. This carries five 4-pound miniature bombs. This rack is operated manually.

Another rack, the Mk 46, can be used only for horizontal bombing because it has no spring mechanism to eject the bomb. It is simply a box with hinged bottom doors which carries one 13-pound miniature bomb. The doors are opened electrically. The rack has a hinged cover so that it can be reloaded during flight.

BOMB SHACKLES

Shackles are used instead of racks in planes which carry their bombs on vertical rails attached to the side of a bomb bay or at the center of the bay.

As you know, shackles are not permanently fastened to the plane like racks, but are attached with a hinged connection to hooks on the rails in the

bomb bay. Shackles can be, and often are, fastened to the bomb before it is mounted to the plane.

Army-type airplanes usually suspend bombs internally, and many Navy planes are Army types taken over by the Navy—such as the Liberator and the Mitchell. On these, the Mk 5 shackle is used. This is very similar to Army shackles—in fact, can be used interchangeably with Army equipment.

As you can see from figure 49, the operating mechanism of the Mk 5 shackle has no direct connection with the plane. The two levers sticking up from the shackle, which control the releasing and arming mechanisms, mate with slots on a RELEASE MECHANISM attached to the plane. Figure 50 shows a release mechanism. The levers of the release mechanism can be operated from the bomber's compartment, electrically or manually.

There are two types of release mechanism, the A-2 and the N-2. In both types, the bomb can be released manually, but only in the unarmed condition. So, manual release is used ONLY to JETTISON bombs. Manual release, moreover, is always in salvo—all the bombs in the bay are dropped at once.

When bombs are to be dropped armed, they are always released ELECTRICALLY. The A-2 type mechanism provides only for selective—one at a time—electrical release. The N-2 mechanism permits EITHER selective or salvo release with the electrical system. This is accomplished by the use of two separate electrical systems, and the N-2 mechanism, therefore, has to have two electrical connections to the plane.

The Mk 5 shackle has the usual two suspension hooks 14 inches apart and can carry any bomb weighing from 25 pounds up to 1,600 pounds.

A few planes of NAVY DESIGN also suspend bombs in bomb bays. In these planes, shackles are

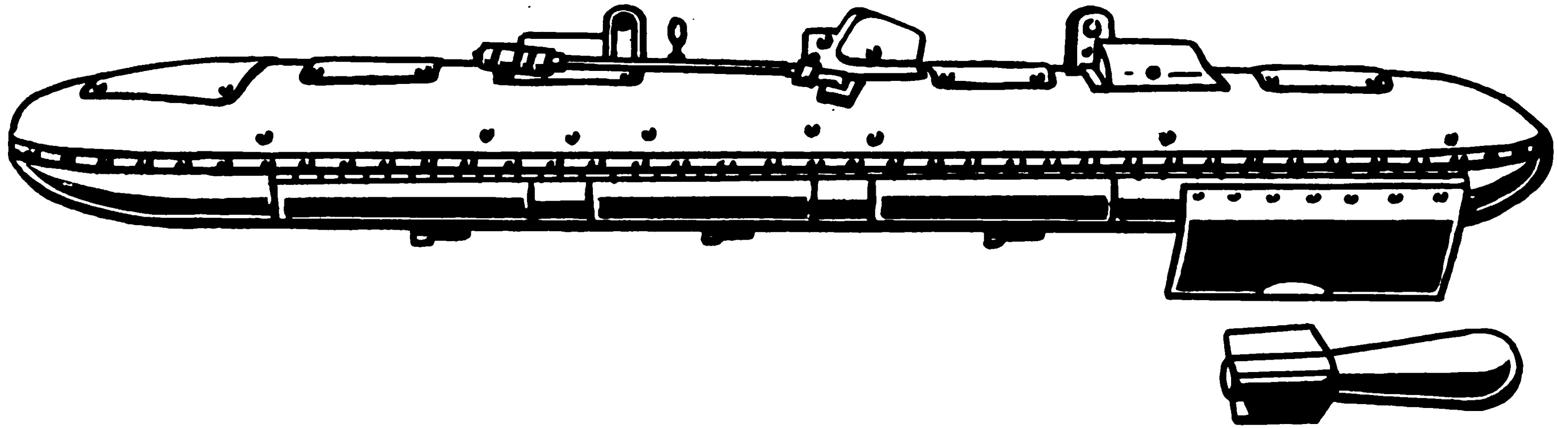


Figure 48.—The Mk 47 practice rack holds eight miniature bombs. One is being dropped.

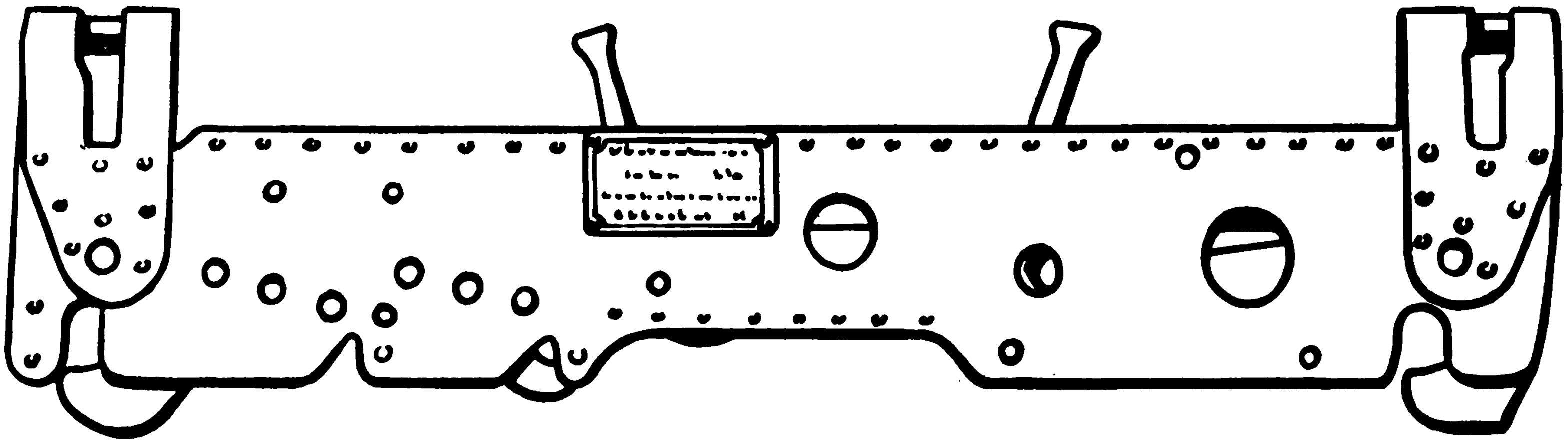


Figure 49.—The two levers protruding from this Mk 5 shackle mate with levers on a bomb release mechanism.

used which are much more like racks in their construction. That is, the arming and releasing mechanism is BUILT INTO the shackle instead of being in a separate release mechanism.

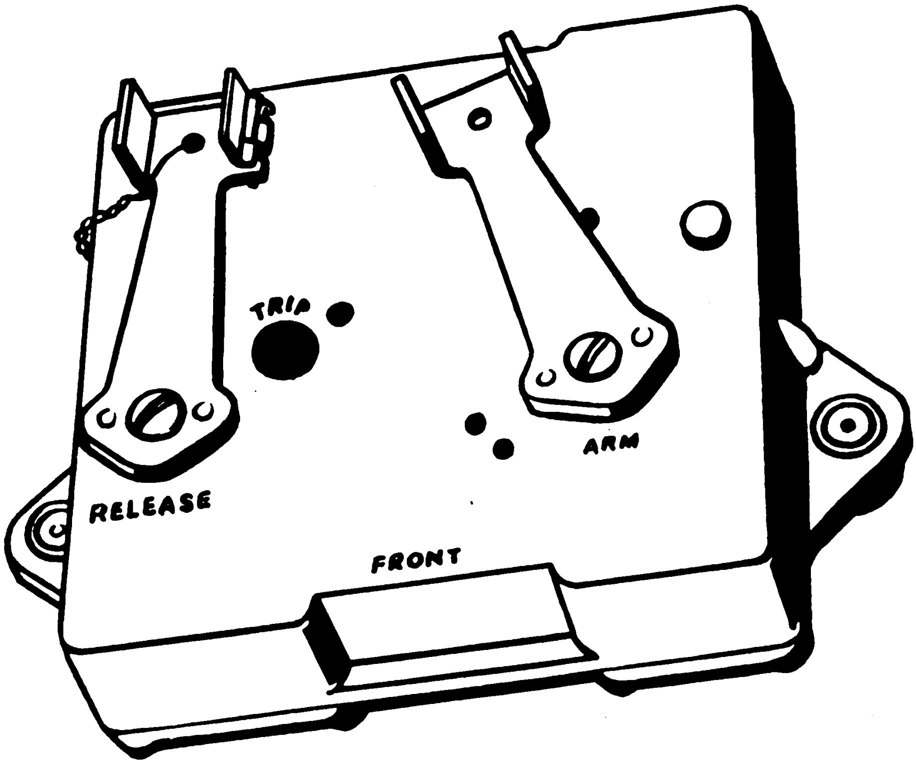


Figure 50.—This Bomb Release Mechanism is the N-2 type with two electric circuits.

These two shackles are the Mk 3 and the Mk 4. The chief difference between them is that the Mk 3 is ARMED electrically, while the Mk 4 is ARMED manually. The Mk 3 shackle has completely selective arming while the Mk 4 is semi-selective. Both provide for electrical or manual release. A peculiarity of these shackles is that before bombs are released electrically, the shackles must be UNLOCKED manually. On the Mk 3 this is done by a partial movement of the bomb release handle, and on the Mk 4 by manually arming the bombs.

The Mk 3 shackle is used in PATROL BOMBERS such as the PB2Y Coronado and PV-1 Ventura where the construction of the plane makes provi-

sion for manual arming difficult. The Mk 4 is used in TORPEDO BOMBERS.

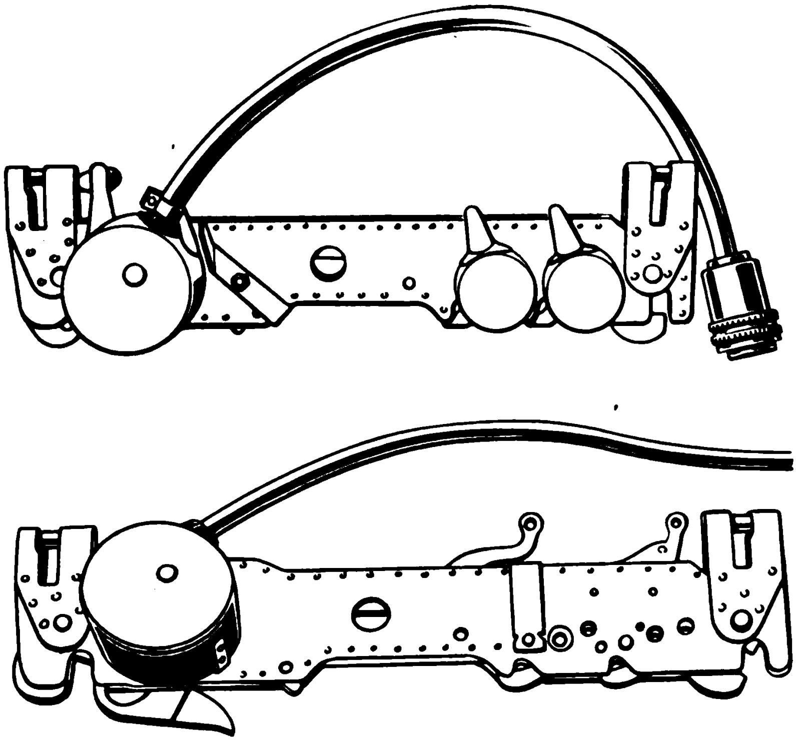


Figure 51.—The Mk 3 shackle, top, has electric arming while the Mk 4, bottom, arms manually.

HOW TO LOAD A BOMB

Loading bombs into a rack is not very difficult but it must be done right. The procedure is similar for each type of rack. For the purpose of explanation, however, here's how it's done on the Mk 51, the most common type of rack.

First, test the BOMB RELEASE HANDLE in the cockpit and the connecting cables to see that they move freely.

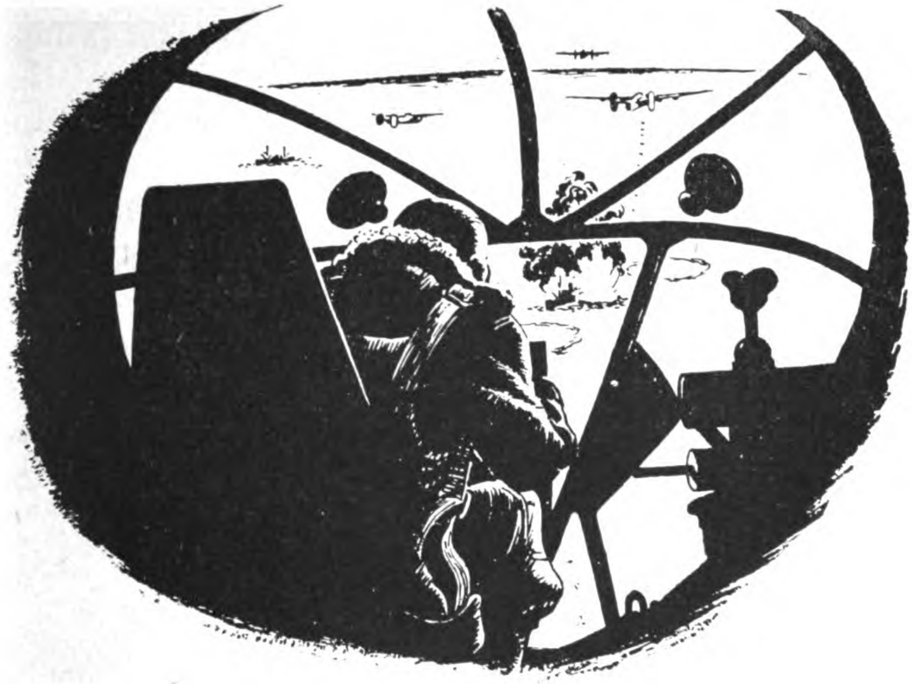
Test the ARMING mechanism. Try the arming handle at its three positions—"arm," "tail arm," and "safe." In the armed position, you should NOT be able to pull the arming wire retainers. Set the arming handle of the manual BOMB RELEASE at "safe" and test the ELECTRIC ARMING SWITCH at its four stages—"both arm," "nose arm," "tail arm," and "safe."

To test the RELEASE MECHANISM, close the bomb suspension hooks by rotating them by hand into the closed position. Then operate the release handle in the cockpit to see whether the lever and connecting cables operate freely and the suspension hooks spring open. Then close the bomb suspension hooks again and operate the rack by means of the ELECTRICAL system.

Now you are ready to HOIST the bomb into the rack. First hang the little brass plates on the end of the arming wire on the retainers. You have to do this BEFORE you hoist the bomb, because of the small clearance between the bomb and the rack, once the bomb is loaded.

Next open the bomb suspension hooks, hoist the bomb into place and close the hooks. You are now ready to thread the ARMING WIRES through the fuzes, secure them, and remove the safety pins from the fuzes.

Bombs weighing 100 pounds or less are usually hoisted into place by hand, but larger bombs must be lifted with a PORTABLE BOMB HOIST, a type of winch, and a cable. For some types of mounting, the bomb hoist is fastened to the side of the rack. There are special fittings on the rack to attach the hoist. When bombs are mounted UNDER THE WING of an airplane the hoist is usually put on top of the wing. Then the cable is run through a hole in the wing and down through the center of the rack to the bomb.



CHAPTER 6

BOMB RELEASE SYSTEMS

WHAT THEY ARE—WHAT THEY DO

Now that you know how bombs are dropped and armed, you are ready to study the entire bomb release system of the airplane.

What is a bomb release system? What does it have to do?

Remember that the bomber has just ONE bomb release switch. He may have as many as TWENTY bombs mounted in a bomb bay, or under the wings or both. He must have some way he can PICK THE PARTICULAR BOMB to be dropped or another way in which he can drop the bombs rapidly ONE AFTER ANOTHER. Moreover, he often wants to drop a string of bombs across the target, SPACED 10 feet, 50 feet, 100 feet apart. This gives him a much better chance of hitting the target and is called dropping the bombs "in train."

Also, the bombs must be dropped in an order

which will not UNBALANCE the plane. The bomber mustn't drop all the bombs on one side and then all on the other side—he must ALTERNATE, first on one side, then on the other.

The bomb release SYSTEM has to be set up so that the bomber can have a complete and easy choice of how he will drop his bombs.

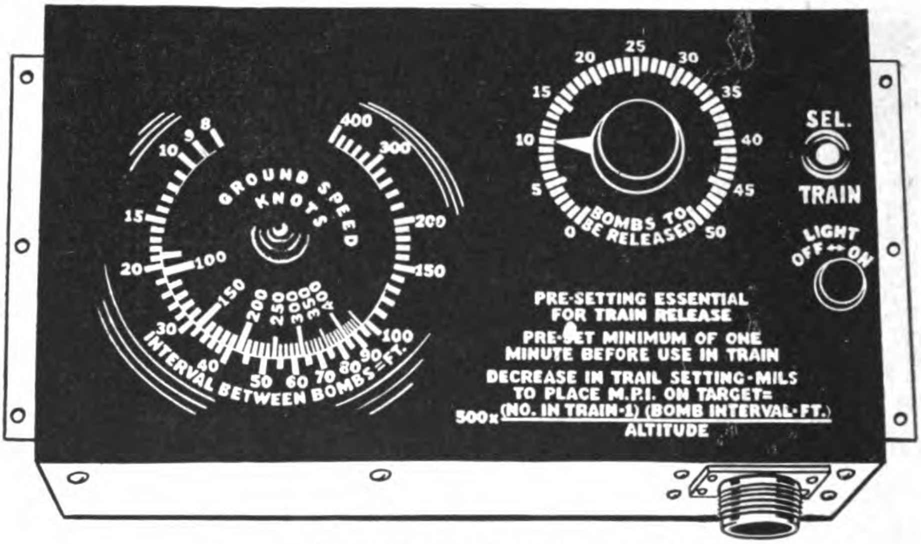


Figure 52.—Single-wire intervalometer.

Several important pieces of equipment are required to accomplish this. One of the most important and delicate is the INTERVALOMETER. This instrument (fig. 52) is a TIMING device designed to send out a series of electric impulses to operate the bomb racks. The impulses are SPACED just the right fraction of a second apart to drop the bombs IN TRAIN so that they will land the right DISTANCE apart. Also it is a COMPUTING device to figure out what that time interval should be.

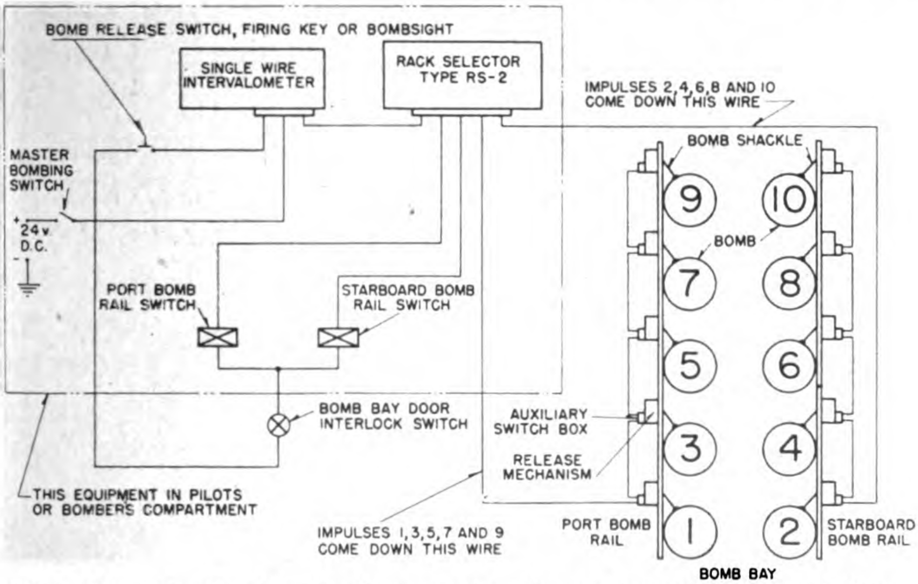
Suppose for instance, the bomber wants to drop 10 bombs 60 feet apart. The plane is flying at a ground speed of 285 knots. Then the bomber sets the upper right-hand SWITCH at "train." He sets the COUNTER knob to "10." And then he turns the INNER ground speed dial to bring 285 knots opposite 60 feet on the OUTER dial. These are the settings which have been made in figure 52. When

the bomb release switch is pressed, the intervalometer will send 10 impulses spaced so that the bombs will land 60 feet apart.

There are two types of intervalometers—the MULTI-WIRE and the SINGLE-WIRE. The multi-wire intervalometer has 13 outlet wires. These are connected to the different bomb stations, and when the intervalometer is operating it sends out a series of electrical impulses, one on each wire.

The single-wire intervalometer is the more common type. Here there is only one outlet wire and all the impulses are sent out along this wire.

With a single wire in the intervalometer you need some device to unscramble the impulses com-



53.—**Elements of a bomb release system for a plane with a bomb bay.**

ing along the single wire and distribute them to the different bomb stations. There are two such devices used. One is the BOMB RACK SELECTOR and the other is the BOMB STATION DISTRIBUTOR.

The bomb rack selector is usually used with planes which carry their bombs in a BOMB BAY. It is connected to the single-wire intervalometer and has TWO outlets. It distributes the impulses coming from the intervalometer so that they go out alternately along one outlet wire and then along

the other—one impulse to the first circuit, then one to the second circuit, again to the first circuit, and again to the second circuit, etc. This serves to insure that the bombs will be dropped evenly from BOTH SIDES of the plane and keep it on an even keel.

Mounted on each rack, shackle, or bomb release mechanism, in a circuit using the rack selector, is a TRANSFER SWITCH. This is a switch which closes when the release mechanism of the rack or shackle operates. Once the switch is closed, it passes on the next impulse to the NEXT bomb station.

BEGINNING AN ATTACK

Figure 53 shows a drawing of a typical bomb release system employing a bomb rack selector. Here is what happens when a bomber decides to make an attack.

First, he opens the BOMB BAY DOORS, and this automatically closes the bomb bay door INTERLOCK SWITCH. (This switch is there to make sure that the bombs are not dropped while the door is closed.) Then the bomber closes the two RAIL SWITCHES on his panel. He sets up the controls on the INTERVALOMETER by selecting the spacing of the bombs and the number of bombs to be dropped and puts the "trainsel" switch into the "train" position. Finally, he closes the MASTER BOMBING SWITCH.

At the proper instant, the bomber—or the bombsight—operates the BOMB RELEASE SWITCH. The intervalometer sends out its first impulse, which is shunted to the right hand side by the RACK SELECTOR. The signal goes to the lowermost bomb station on the right-hand side of the bay, and the bomb is DROPPED. At the same time the TRANSFER SWITCH is closed.

The next signal from the intervalometer goes to the lowermost left-hand station. A second bomb is dropped, and that transfer switch is closed.

The third signal from the intervalometer is shunted back to the right side, passes THROUGH the transfer switch of the lowermost bomb station and goes to the next station up, dropping that bomb and closing the corresponding transfer switch. And so on, until the number of bombs set on the intervalometer has been dropped.

WING-MOUNTED BOMBS

Planes in which the bombs are carried under the wings or are racked in a bomb bay side by side instead of one on top of the other may use a BOMB

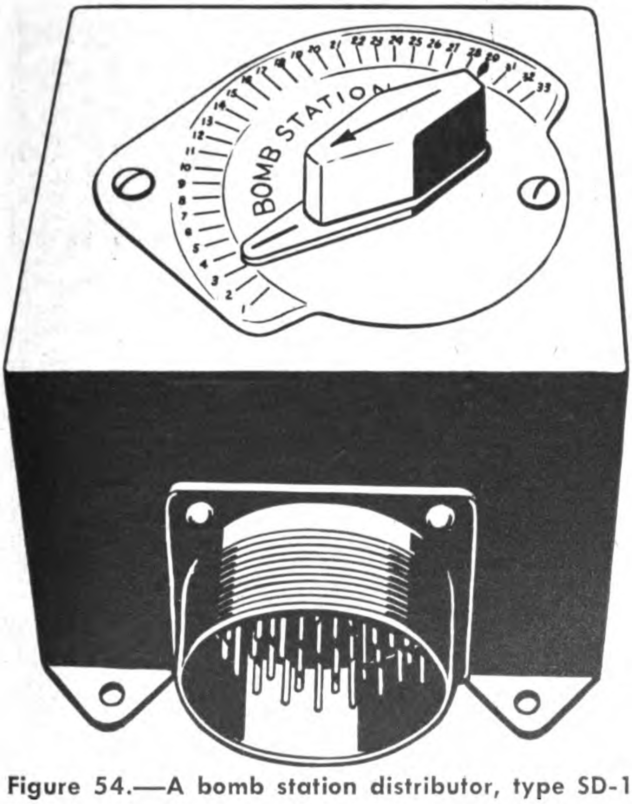


Figure 54.—A bomb station distributor, type SD-1.

STATION DISTRIBUTOR (fig. 54) with a single-wire intervalometer, in place of the rack selector. The station distributor receives electrical impulses through the single-wire from the intervalometer and distributes them to the different bomb stations through as many as 32 different outlet wires.

The station distributor can be used with both

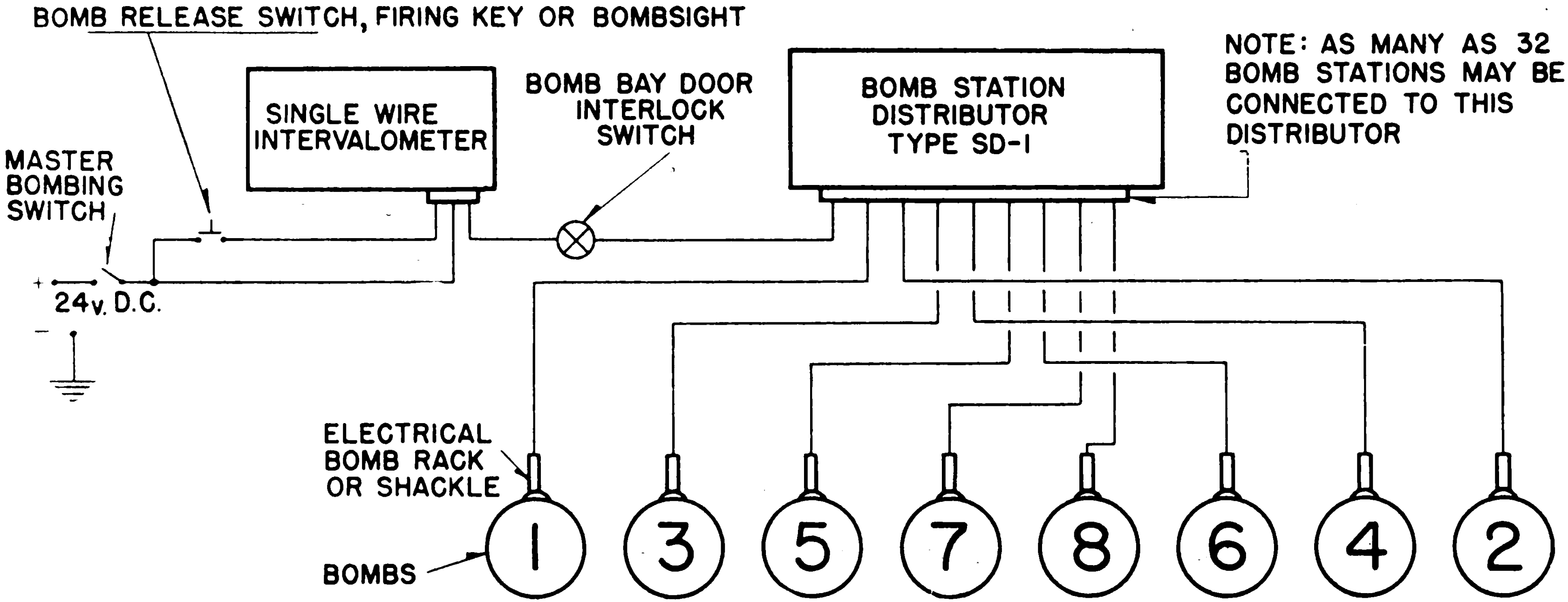


Figure 55.—This release system can be used when bombs are hung under the wings or side by side in a bomb bay.

selective and train bomb release. For SELECTIVE release, the pointer of the distributor is set by hand to the number on the dial corresponding to the bomb station desired. For train release, the pointer is set to the number of the FIRST bomb to be released, and succeeding bombs will be dropped in numerical order.

Figure 55 shows a typical hookup for a bomb release system using a station distributor. Here is what happens when bombs are to be dropped.

The bomber opens the BOMB BAY DOORS, and the bomb bay door INTERLOCK SWITCH closes automatically.

Then the controls on the INTERVALOMETER are set up as before.

The bomber sets the indicator on the BOMB STATION DISTRIBUTOR to the number of the FIRST bomb desired to be released—say No. 4.

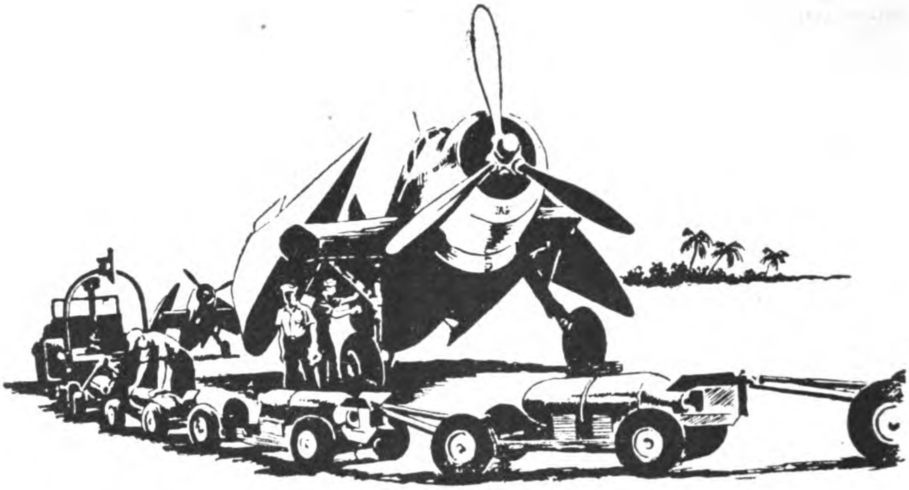
Then the MASTER BOMBING SWITCH is closed and everything is ready.

Over the target, the bomber operates the BOMB RELEASE SWITCH. The intervalometer sends out an impulse which is shunted by the bomb station distributor to station 4. That bomb is dropped. Another impulse comes from the intervalometer and is shunted to station 5. The next impulse goes to station 6, the next to station 7, and so on.

HANDLE WITH CARE

Always remember that intervalometers, station distributors, and rack selectors are comparatively delicate instruments. They are rugged enough to withstand normal handling and vibration but should not be subjected to unnecessary roughness and abuse.

NEVER clean, repair, or adjust these pieces of equipment in any way. Work on intervalometers, selectors and distributors should only be done by men specially trained for this purpose.



CHAPTER 7

BOMB HANDLING EQUIPMENT

A BIG JOB FOR YOU

Cannon balls were not originally intended for the decoration of military monuments. The same goes for modern aerial bombs.

As they leave the factories, you may see several addresses chalked up for special delivery—"HELLO, HITLER!" or, "DESTINATION, TOKYO!"

Presently these bombs are at an advanced base, or aboard a carrier, en route. In preparation for final delivery, YOU must take them out of storage, make them ready, and load them into airplanes for the final leg of their journey. BOMB HANDLING EQUIPMENT is the name which covers all of the various and sundry pieces of apparatus with which you transport your bombs, torpedoes, and mines from the magazine INTO the airplane.

This equipment varies a good deal, for different items are designed to meet different conditions. As an example, you might think that one bomb truck would serve all purposes—but bombs vary in weight from say 5 to 2,000 pounds, and they may be loaded from a concrete ramp in California, a

frozen tundra in the Aleutians, or a muddy compound in the South Pacific.

Likewise, some airplanes carry bombs under their wings, while others carry them inside their fuselages. This fine dissimilarity plus the variations in the design of different aircraft, calls for a change in bomb loading procedure between one airplane and another.

You yourself may one day dream up some gadget that will make the loading of bombs in the airplanes of your squadron a more efficient, speedier, and safer process under certain operating conditions. From such original ideas have come many pieces of equipment now listed in the BuOrd catalogs.

But the main idea at present is not for you to begin working on a revolutionary new invention, but rather for you to learn something about the various types of bomb handling equipment now in use on the far-flung shore stations and the ships of the fleet so that you won't do a job the hard way when there is equipment readily available that will simplify it for you.

HOISTING BANDS

Before you can hoist a bomb around with winches and such, you must have some means of securing a cable to the bomb body.

Most bomb cases have suspension lugs by which the bomb is suspended from the racks in the airplane, but if you are trying to fasten a lug onto the rack, it wouldn't do to have your hoisting cable fastened to the bomb lug, too. You must have some means of securing a cable to the bomb body while leaving the lugs free to be secured to the suspension hooks. For this purpose, you have HOISTING BANDS.

Some Navy bombs have welded-on hoisting lugs and some are furnished with hoisting bands al-

ready fixed in place. But when bombs are not issued to your squadron with bands already attached—and most bombs will not have them—you must attach them yourself in order to be able to move the bomb about.

Hoisting bands are designed to handle bombs and torpedoes from 500 to 4,000 pounds in weight.

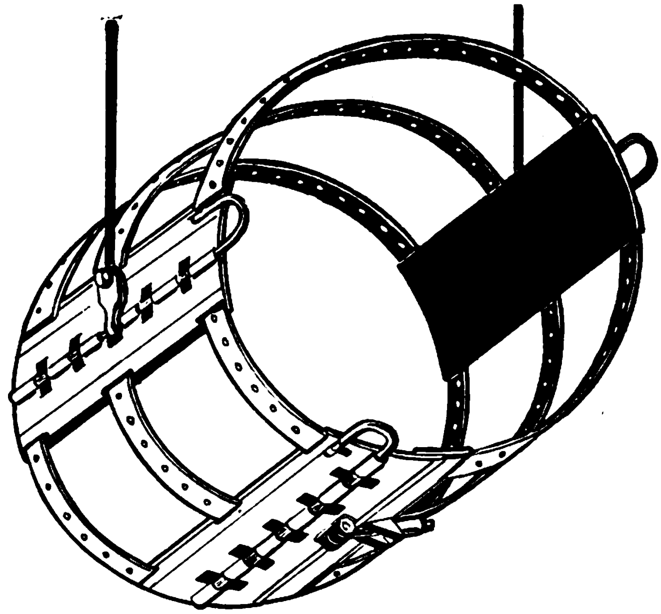


Figure 56.—Universal hoisting band, MK 8.

The hoisting band, Mark 8, is rapidly replacing all other hoisting bands, for it can be used with practically any bomb, and it can be installed and removed quickly and easily. This band can handle any bomb, torpedo, or mine weighing up to 2,000 pounds with a single hoist. Using two bands and two hoists, you can raise bombs twice that weight.

You will also encounter bands especially made for particular size bombs.

BOMB AND TORPEDO SKIDS

Skids CARRY the bombs.

Some skids have wheels and some don't. One example of each type is shown in figures 57 and 58.

The BOMB SKID Mk 3 is simply a strong steel frame on which you can cradle any bomb or torpedo weighing up to 2,000 pounds.

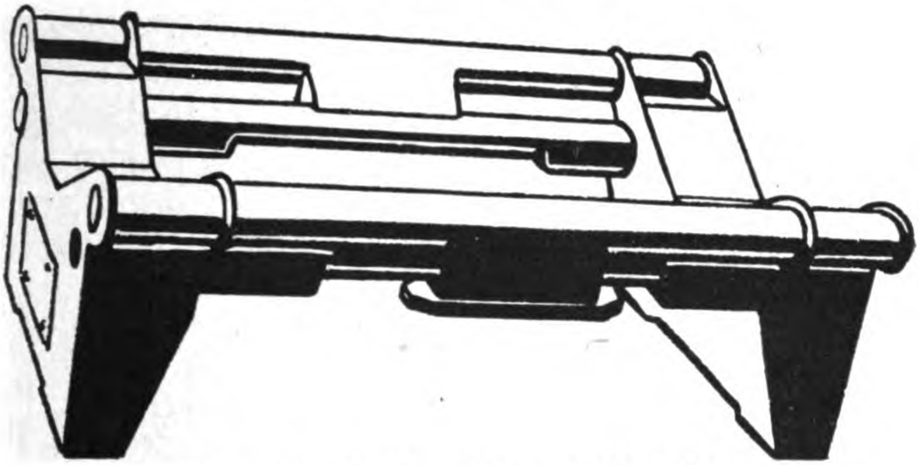


Figure 57.—Bomb and torpedo skid, Mk 3.

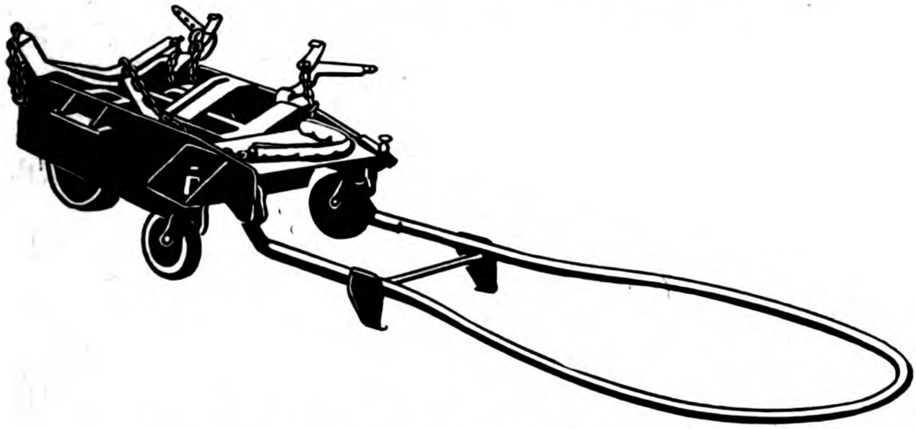


Figure 58.—Bomb and torpedo skid, Mk 5, Mod. 1.

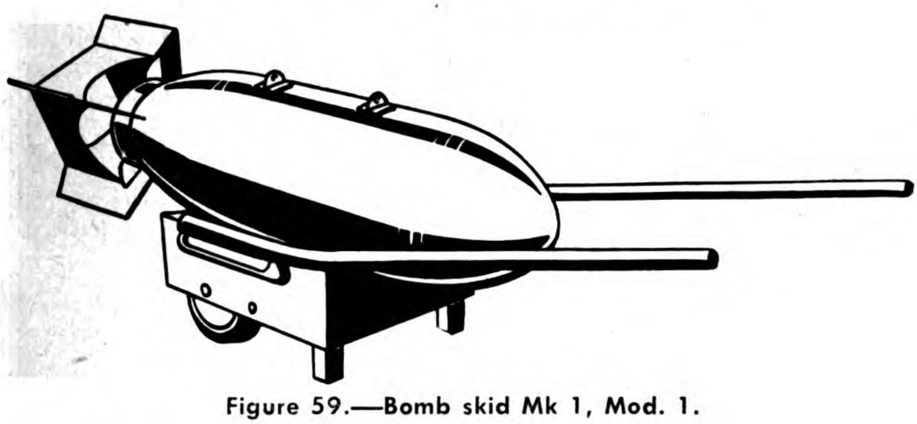


Figure 59.—Bomb skid Mk 1, Mod. 1.

The Mark 5, Mod. 1, however, can transport bombs or torpedoes up to 2,500 pounds in weight.

It will roll easily on any hard surface, and it carries straps or chains to keep the load from sliding off en route.

The Mark 1, Mod. 1 bomb skid, illustrated in figure 59, is a wheelbarrow-like affair which will carry up to 1,000 pounds. Its rubber-tired wheels will roll easily on a carrier deck, or on the runways of a permanent shore station, and if you have to travel through mud or sand or such, you can replace the rubber-tired wheels with a track-laying attachment.

On extremely soft or uneven terrain, you can use the bomb and torpedo skid, Mark 6. It has two pairs of TRACK-LAYING wheels which will negotiate the roughest type of going, such as you are likely to encounter at a very advanced base.

BOMB AND TORPEDO TRUCKS

A truck is not very different from a skid with wheels, except that most trucks have a hydraulic lift mechanism.

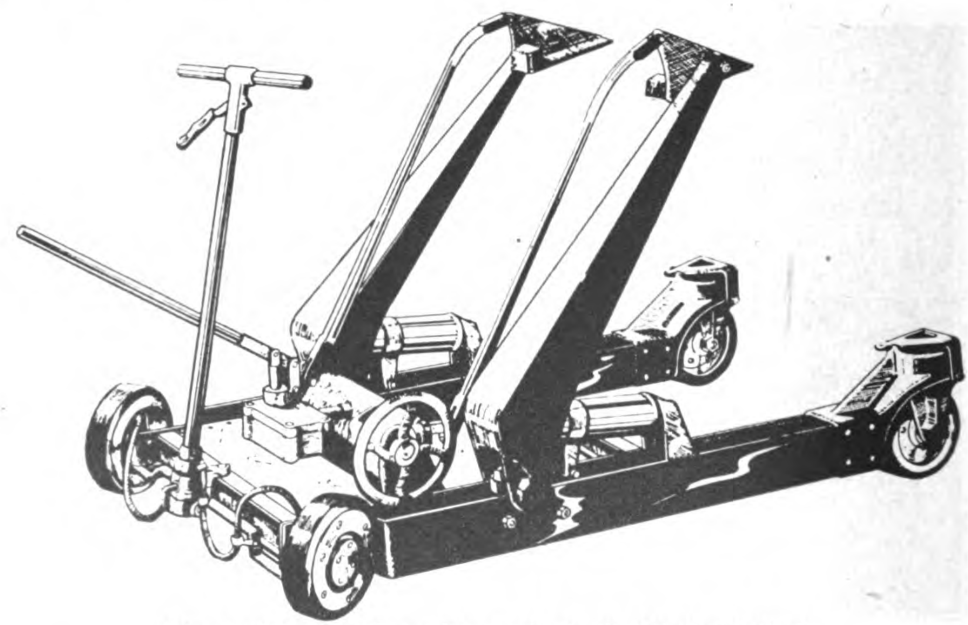


Figure 60.—Bomb and torpedo truck, Mk 2, Mod. 2.

There are two types of trucks—the LOW LIFT type and the HIGH LIFT type.

The low-lift type you can run UNDER a skid, and by means of the hydraulic lift, raise the skid, carry it under the airplane and lower it again.

The high-lift truck not only will move a bomb or a loaded skid, but it will raise the load to a bomb rack or shackle on the wing or in the bomb bay of an airplane.

Figure 60 shows the bomb and torpedo truck Mk 2, Mod. 2. This is a high-lift type. A bomb skid will rest on lift arms which are shown in their raised position. The pump handle operates the lift. The hand-wheel tilts the bomb.

TRAILERS

At bases where you have concrete runways and ramps, you can use trailers to carry the bombs from the magazines to the airplanes. The main advantage of the trailer lies in the fact that you can run a train of two, three, or four trailers towed by a bomb service truck or tractor.

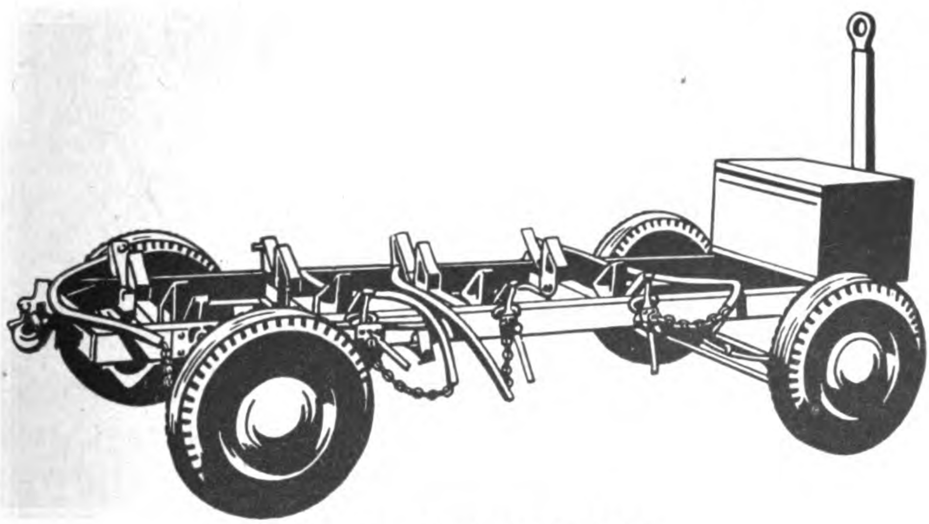


Figure 61.—Bomb trailer, Mk 1.

Each trailer has a capacity of 2,000 pounds, and each is equipped with electric brakes which are operated by the driver of the towing vehicle.

After you have the bombs under the airplane, you have to RAISE them into position. When you are working with bombs too heavy for you and your mates to lift by yourselves, you use a BOMB HOIST.

There are two types of hoists — the manual, crank-operated type, and the electrically-powered type.

Bomb hoists are designed for specific tasks. For example, in patrol planes, bombs and torpedoes are

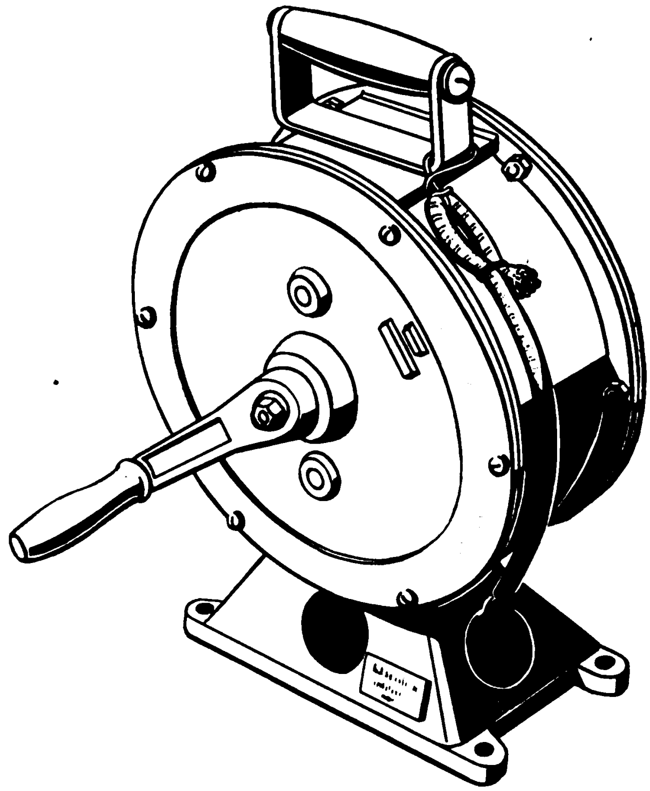


Figure 62.—Portable bomb hoist, Mk 6.

suspended from the wings. Hence to load a PBY airplane with bombs, you need a hoist that carries a long cable because of the great distance from the ground to the under side of the wing.

You will be using manually operated hoists more frequently than the electric type. Figure 62 shows the portable bomb hoist Mark 6 which can raise

1,000 pounds to a height of almost 15 feet. This hoist is mounted on top of a wing, and the cable is run through holes in the wing and through the center of the rack.

Another type of manual hoist has an extension tube and is used from the side. The pulley at the end of the tube is hooked over the bracket at the side of the rack. Figure 63 shows such a hoist.

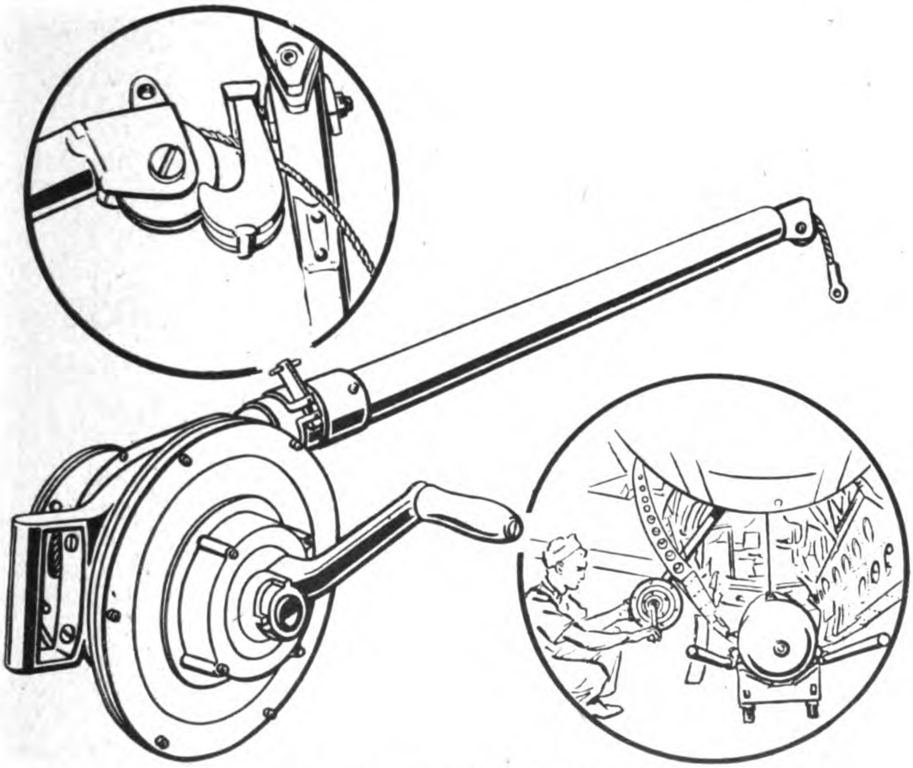


Figure 63.—Portable bomb hoist, Mk. 7.

The maintenance of any bomb handling equipment that has mechanical, moving parts is mainly a matter of LUBRICATION. A grease gun and an oil can are all that you will need, and the lubricating points are easy to find.

How Well Do You Know

AIRCRAFT ARMAMENT

QUIZ

CHAPTER 1

KNOWLEDGE PAYS DIVIDENDS

1. What is the difference between the designations "Mk" and "Mod"?
2. What is the Army equivalent for the Navy designation "Mk"?
3. In writing reports on equipment, how much of the designation for the various items must you use?
4. What does "AN" stand for?

CHAPTER 2

HOW GUNS OPERATE

1. What makes a gun kick?
2. In any gun, what is the function of the—
   (*a*) Chamber?
   (*b*) Firing pin?
   (*c*) Hammer?
   (*d*) Sear?
3. (*a*) What name is given to the gun group which contains most of the gun's moving parts?
   (*b*) What gun group holds this group?
4. (*a*) By what part of a gun are "caliber" and "gage" measured?
   (*b*) To what type of gun does each of these measurements apply?
5. (*a*) As bore size increases, how will caliber numbers change?
   (*b*) As bore size increases, how will gage numbers change?
   (*c*) Explain your answers to *a* and *b*.
6. In the Springfield rifle, what is the function of the—
   (*a*) Magazine cutoff?

(*b*) Safety?

7. Where on the Springfield will you find each of the parts mentioned in question 6?
8. In the Springfield rifle, —
   (*a*) How is the cartridge extracted?
   (*b*) What happens when the trigger is pulled?
9. A semi-automatic gun relieves the gunner of all the firing operations except one. What is that one?
10. (*a*) What is the basic force used to operate automatic guns?
    (*b*) Explain briefly how this force is used to operate gas-operated and blowback guns.
    (*c*) What is the third main type of automatic gun?
11. (*a*) Which of the types of operation mentioned in question 10 applies to the Winchester carbine?
    (*b*) How do the actions in Winchester carbines and Springfield rifles differ?
    (*c*) What part is added, in this carbine, to accomplish automatic operation of the action?
12. In the Winchester carbine,
    (*a*) What is the function of the operating spring?
    (*b*) How is the bolt rotated and retracted?
13. (*a*) What type of operation does the automatic pistol use?
    (*b*) Why is the pistol mis-named?
14. (*a*) What part accomplishes the locking of the slide in the automatic pistol?
    (*b*) What part accomplishes the unlocking?
15. (*a*) What kind of gun described in this chapter operates on the simplest principle upon which an automatic gun can work?
    (*b*) What is that principle?
    (*c*) What types of fire is this gun capable of?
16. In the Thompson sub-machine gun—
    (*a*) How is the firing pin cocked?
    (*b*) How is the bolt locked?
17. For each of the following weapons, give the caliber, type of fire and type of operation.
    (*a*) Enfield rifle.
    (*b*) Colt automatic pistol.
    (*c*) Smith & Wesson revolver.
    (*d*) Colt Ace pistol.
18. For each of the following weapons, give the caliber and accurate range.
    (*a*) Springfield rifle.
    (*b*) Winchester carbine.
    (*c*) Browning automatic rifle.

CHAPTER 3

BROWNING MACHINE GUNS

1. For caliber .50 and .30 Browning Aircraft Machine Guns, give the—
   (*a*) Type of operation.
   (*b*) Type of fire.
   (*c*) Type of feed.
   (*d*) Rate of fire.
2. (*a*) Is the BAM breech locked during recoil? How?
   (*b*) How does it unlock?
   (*c*) Is the breech locked before or after the gun returns to battery?
3. What does the accelerator accelerate?
4. (*a*) What part cocks the firing pin? Where is it located?
   (*b*) Does this happen during recoil or counter recoil?
   (*c*) How is the firing pin released in a free BAM? A fixed BAM?
5. (*a*) What is the purpose of the grooves in the top of the bolt?
   (*b*) Why are there two of them?
6. What are the 6 groups into which the BAM parts are divided for convenience in assembly and disassembly?
7. (*a*) How is routine cleaning of a BAM performed?
   (*b*) What special precaution is necessary before lubrication?
   (*c*) What special handling does a gun just received from storage require?
8. Describe the lubrication procedure for—
   (*a*) Normal temperatures.
   (*b*) Temperatures lower than 30° below zero.
9. (*a*) What does a gun do when headspace is too tight?
   (*b*) What is the best way to tell whether the headspace is too tight?
10. (*a*) What will happen to a gun with loose headspace?
    (*b*) What part do you move to change the headspace?
11. (*a*) What adjustment is almost as important as headspace?
    (*b*) How do you tell whether or not this adjustment is correct?

(*c*) If it is not correct, how do you change it?

12. When you assemble a gun, which way should the cocking lever point when you place the bolt in the receiver?
13. What is the basic difference between flexible and fixed guns?
14. What are some of the things you should check before the takeoff of an airplane whose armament is in your charge? When it returns?

CHAPTER 4

20 MM AUTOMATIC

1. (*a*) What type of operation does the 20 mm automatic use?
   (*b*) What type of feed does it use?
   (*c*) What is its rate of fire?
2. Why is the 20 mm automatic sometimes called a cannon?
3. How and when is the bolt locked? How is it unlocked?
4. What is the function of the inertia blocks?
5. What holds the bolt cocked? How?
6. Explain how the electric trigger fires the gun.
7. What stops the bolt's backward movement on the recoil stroke? What else does it do to the bolt?
8. What device moves the belt feed? Where does its energy come from?
9. What is a hang fire?
10. What is a cooked-off round?

CHAPTER 5

RACKS AND SHACKLES

1. What is meant by "arming" a bomb?
2. (*a*) What is the difference between racks and shackles?
   (*b*) Where would you expect to find a rack used?
3. Would you expect to find both manual and electrical release on the same rack?
4. What is the difference between selective and semi-selective arming?

5. (*a*) What is the Mk number of the most modern 2-hook rack? Single-hook rack?
   (*b*) What weight bomb can be carried on each of these racks?
6. Is electrical arming of the Mk 51 rack selective or semi-selective?
7. What rack would you use for dive bombing practice with miniature bombs?
8. What is a release mechanism?
9. How far apart are the suspension lugs on a Mk 51 rack? On a Mk 3 shackle?
10. (*a*) What is the chief difference between the Mk 3 and Mk 4 shackle?
    (*b*) How do they differ from the Mk 5?
11. How do you test the arming mechanism on a bomb rack?
12. Do you remove the safety pins from a fuze before or after attaching the arming wire to the rack? Before or after threading the wire through the fuze?

CHAPTER 6

BOMB RELEASE SYSTEMS

1. What is the purpose of an intervalometer?
2. (*a*) What determines whether you would use a bomb rack selector or a station distributor in an airplane?
   (*b*) What is the function of each?
3. What is a transfer switch?
4. How do you lubricate an intervalometer?

CHAPTER 7

BOMB HANDLING EQUIPMENT

1. What are hoisting bands used for?
2. What are bomb skids used for?
3. (*a*) What is the difference between a skid and a truck?
   (*b*) Would you ever use a bomb skid and a bomb truck together?
4. What is the purpose of the extension tube on a Mk 7 bomb hoist?

ANSWERS TO QUIZ

CHAPTER 1

KNOWLEDGE PAYS DIVIDENDS

1. "Mk" identifies a new design or pattern of a particular type of equipment, whereas "Mod" denotes a change so slight that it does not affect the basic design.
2. "M."
3. The complete designation for each new item mentioned.
4. Standardized for use by Army and Navy.

CHAPTER 2

HOW GUNS OPERATE

1. The pressure against the breech plug (bolt) as the gas formed by the burning gunpowder expands within the cartridge chamber.
2. (*a*) To hold the cartridge.
   (*b*) To explode the primer.
   (*c*) To drive the firing pin against the primer.
   (*d*) To cock the gun.
3. (*a*) Action.
   (*b*) Receiver.
4. (*a*) Bore (before rifling).
   (*b*) Caliber—rifle.
   Gage—shotgun.
5. (*a*) Caliber numbers will increase (be higher).
   (*b*) Gage numbers will decrease (be lower).
   (*c*) Caliber is a direct measure of bore size (before rifling), whereas gage represents not the size of the bore but the number of lead balls of bore diameter which would be required to weigh one pound. Therefore the larger the rifle the HIGHER THE CALIBER, but the larger the shotgun the

fewer balls per pound and the LOWER THE GAGE.

6. (*a*) To adjust the rifle for repeating or single-shot operation.
   (*b*) To prevent accidental firing while the rifle is cocked.
7. Magazine cutoff—left side of receiver.
   Safety—rear end of bolt.
8. See pages 12 and 13.
9. Pulling the trigger.
10. (*a*) The waste power of the cartridge.
    (*b*) Gas-operated guns are activated by the force of a piston driven by the expanding gas; whereas blowback guns are activated by backward movement of the bolt driven by the gas.
    (*c*) Recoil.
11. (*a*) Gas.
    (*b*) The carbine firing pin is moved by a hammer rather than by a spring as in the rifle.
    (*c*) Slide.
12. (*a*) To drive the slide (and bolt) forward so that a fresh cartridge is rammed into the chamber.
    (*b*) See pages 17-19.
13. (*a*) Recoil.
    (*b*) Because it is actually a semi-automatic pistol (the trigger must be pulled each time the gun is fired).
14. (*a*) Ribs.
    (*b*) Link.
15. (*a*) Thompson sub-machine gun. (Or: Sub-machine gun caliber .45 M3.)
    (*b*) Blowback.
    (*c*) Automatic and semi-automatic. (Or: Automatic only.)
16. (*a*) It is not cocked.
    (*b*) It is not locked.

17.

	Caliber	Fire	Operation
(*a*)	.30	Repeating	Manual
(*b*)	.45	Semi-auto.	Recoil
(*c*)	.38	Repeating	Manual
(*d*)	.22	Semi-auto.	Recoil

18.

	Caliber	Accurate Range
(*a*)	.30	600 yards
(*b*)	.30	300 yards
(*c*)	.30	600 yards

CHAPTER 3

BROWNING MACHINE GUNS

1. (*a*) Recoil.
   (*b*) Full automatic.
   (*c*) Belt.
   (*d*) 400 to 500 rounds per minute (.50 caliber). 1,350 rounds per minute (.30 caliber).
2. (*a*) During the first part of the recoil stroke. By the breech lock, a metal plate which, when lifted, fits into a notch in the underside of the breech bolt.
   (*b*) The breech lock moves off the cam ramp on the floor of the receiver and is pushed downward by the lock depressors.
   (*c*) Before.
3. The backward movement of the bolt during recoil.
4. (*a*) Cocking lever. It protrudes from the top of the bolt.
   (*b*) Recoil.
   (*c*) See pages 41 and 42.
5. (*a*) To drive the belt feed lever.
   (*b*) So that the gun can be set up to feed from either right or left.
6. Receiver group.
   Cover group.
   Back plate group.
   Oil buffer (or Lock frame) group.
   Barrel group.
   Bolt group.
7. (*a*) All movable parts are disassembled and thoroughly wiped with dry-cleaning solvent; bore is swabbed with rifle bore cleaner until a clean flannel patch picks up no foreign matter.
   (*b*) Cloth gloves should be worn, so that perspiration from the hands cannot corrode the unprotected metal.
   (*c*) A special cleaning job to remove the heavy grease in which guns are stored and shipped. (See page 60.)
8. (*a*) Disassemble gun; wipe all parts with an oily cloth saturated with special preservative lubricating oil.
   (*b*) Disassemble gun; wipe all parts with a clean lintless cloth which has been saturated in oil

and then wrung dry; remove as much of the oil as possible with a dry clean lintless cloth.

9. (*a*) The gun will not fire, or if it fires it will not feed. (See pages 62-63.)
   (*b*) Check it with a No-Go gage.
10. (*a*) Accuracy will be impaired. (The cartridge may or may not seat all the way.)
    (*b*) Barrel.
11. (*a*) Timing.
    (*b*) Check it with the timing end of the timing-headspace gage. (See pages 64-65.)
    (*c*) By screwing the solenoid shaft in or out, on a fixed gun; or by replacing the trigger bar with a longer or shorter bar, on a flexible gun.
12. Forward.
13. Flexible guns are swivel-mounted in the fuselage and are aimed by an individual gunner; fixed guns are rigidly fastened to the frame of the airplane and are carefully lined up with the airplane so that the pilot can aim them by aiming the plane.
14. See pages 64 and 71.

CHAPTER 4

20 MM AUTOMATIC

1. (*a*) Blowback, gas pressure and recoil.
   (*b*) Belt.
   (*c*) 500 to 800 rounds per minute.
2. Because it shoots shells.
3. See page 76.
4. To prevent the receiver slides from bouncing back, as the gun fires, and unlocking the breech.
5. The sear. By snapping into a notch on the underside of the bolt.
6. See page 83.
7. Rear buffer. Starts it forward again.
8. Sprocket wheels. A coil spring kept wound by the gun's recoil movement.
9. A delay in cartridge explosion for some seconds or minutes after the firing pin strikes the cartridge.
10. A cartridge explosion caused by the heat of the barrel.

CHAPTER 5

RACKS AND SHACKLES

1. Adjusting its fuzes so that they will explode when the bomb hits.
2. (*a*) Racks are solidly and more or less permanently attached to the main structure of the airplane, whereas shackles can be easily detached from the plane.
   (*b*) When bombs are suspended from the underside of a wing or from the top of a bomb bay.
3. Yes. (Racks may be armed and safetied either manually or electrically or both.)
4. Selective arming permits arming of either one or both of the fuzes, whereas semi-selective arming permits arming of the tail fuze only, or both fuzes.
5. (*a*) Mk 51. Mk 50.
   (*b*) Mk 51—25 lbs. to 1600 lbs.
   Mk 50—25 lbs. to 500 lbs.
6. Selective.
7. Mk 47. (Mk 43.)
8. Mechanism, attached to the airplane, for controlling the operation of releasing and arming mechanisms on bomb shackles.
9. 14 inches. Same.
10. (*a*) The Mk 3 is armed electrically (selective arming), whereas the Mk 4 is armed manually (semi-selective arming).
    (*b*) They do not require a separate release mechanism.
11. Try the arming handle in its three positions. In the armed position you should not be able to pull open the arming wire retainers.
12. After. After.

CHAPTER 6

BOMB RELEASE SYSTEMS

1. To control the timing of bomb release so that the bombs will land the correct distance apart.
2. (*a*) The way in which the bombs are carried. (Bomb rack selectors are usually used with planes which carry their bombs in a bomb bay; whereas bomb station distributors are usually

used when the bombs are carried under the wings, or in a bomb bay side by side instead of one on top of another.)

(*b*) Both function to distribute impulses from the intervalometer to the different bomb stations: The bomb rack selector distributes the impulses to alternate racks, whereas the bomb station distributor distributes them direct to the individual bomb stations.

3. A mechanism used with bomb rack selectors, to pass the intervalometer impulses from each individual bomb station to the next station.
4. Intervalometers should be serviced only by men specially trained for this purpose.

CHAPTER 7

BOMB HANDLING EQUIPMENT

1. Securing hoisting cables to bomb bodies while leaving suspension lugs free to be secured to the suspension hooks of the bomb rack.
2. Carrying bombs and torpedoes.
3. (*a*) Most trucks have hydraulic lift mechanisms.
   (*b*) Yes. Trucks can raise loaded skids.
4. To carry a pulley which can be hooked over a bracket at the side of the rack, enabling the hoist to be used from the side.

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